Freight-Car Brake Equipment

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TYPE "AB" FREIGHT BRAKE EQUIPMENT

TYPE K FREIGHT-CAR BRAKE EQUIPMENT

Note: Figs 13-20 in the Type K volume were included in the original book as fold-outs tucked into a packet inside the back cover. They are included in this electronic version at the end of this file.

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Published by

INTERNATIONAL TEXTBOOK COMPANY

SCRANTON, PA.

Printed in U. S. A.

INTERNATIONAL TEXTBOOK PRESS
Scranton, Pa.

84500

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Note.—This book is made up of separate parts, or sections, as indicated by their titles, and the page numbers of each usually begin with 1. In this list of contents the titles of the parts are given in the order in which they appear in the book, and under each title is a full synopsis of the subjects treated.

TYPE "AB" FREIGHT BRAKE EQUIPMENT

TYPE K FREIGHT-CAR BRAKE EQUIPMENT

TYPE "AB" FREIGHT BRAKE EQUIPMENT

Serial 2518 Edition 1

DESCRIPTION AND OPERATION

GENERAL REMARKS

1. **Reason for Development.**—The "AB" freight brake equipment was developed to provide a more effective brake than heretofore for the heavier cars and the faster schedules of modern freight trains. The principal new features of this equipment are an improved quick service, an improved release, the elimination of undesired emergency during a service application, and a controlled development of brake-cylinder pressure in emergency.

2. **Arrangement of Equipment.**—A piping diagram of the "AB" freight brake equipment is shown in Plate 11 in the back of this lesson paper. The equipment is made up of the following parts: An "AB" valve, a brake cylinder, a two-compartment reservoir, which comprises an auxiliary reservoir and an emergency reservoir, a combined dirt collector and a cut-out cock mounted on the pipe bracket of the "AB" valve, a branch-pipe tee bolted to the car underframe by a bolting lug, a pressure-retaining valve, a brake pipe provided with hose and angle cocks, and the necessary piping to make the connection between the various parts.

SPECIAL FEATURES OF EQUIPMENT

3. **Improved Quick Service.**—An improved quick-service application of the brakes provides a prompt and positive application of the brakes on all cars of long modern trains. Following a brake-pipe reduction at the brake valve, quick service is trans-

mitted throughout the train at a rate nearly equal to the emergency rate of the "K" equipment and causes all valves to assume service position. Following this, a brake-cylinder pressure of about 10 pounds is developed throughout the train, regardless of the usual difference in brake-pipe pressure between the front and the rear ends of the train. Since only about 6 pounds of this amount is effective in producing retarding effort on the car, the train slack will be collected gently and without noticeable shock.

4. In heavy-grade territories and with retaining valves maintaining 10 pounds or more pressure in the brake cylinders, the improved quick-service feature is confined only to the rapid movement of the "AB" valves to service, thus insuring a much more flexible control than is possible with the "K" equipment.

5. **Improved Release Feature.**—Irrespective of slide-valve resistance, positive release action is assured whenever the brake-pipe pressure has been increased to 1½ pounds above the pressure in the auxiliary reservoir, hence a stuck brake is practically impossible. This feature reduces train delays, parted trains, and overheated and slid flat wheels.

6. **Quick Recharge Following Service Applications.**—In releasing after a service application, the air in the emergency reservoir which remains unreduced during service applications is allowed to equalize into the auxiliary reservoir, and recharges this reservoir to within a few pounds of initial pressure. This action prevents the auxiliary reservoir from drawing any air from the brake pipe until after the brake-pipe pressure has been raised to a point that will insure the release of all brakes in the train.

This feature produces a very rapid rise in brake-pipe pressure and a much earlier release of all brakes, and makes possible a release of the brakes at slow speeds without the necessity of coming to a stop.

7. **Emergency at Any Time.**—Emergency at any time, used for some years in passenger equipments, is now for the first

time available in a freight brake equipment. With it an emergency application, with a maximum brake-cylinder pressure of 60 pounds from a brake-pipe pressure of 70 pounds, can be secured at any time regardless of the stage of application of the brake.

8. **Protection Against Undesired Emergency.**—The separation of the emergency parts of the valve mechanism from those that govern the service application, eliminates the possibility of undesired emergency action inherent in any triple-valve device, such as the "K", in which both the service and the emergency functions are controlled by the same piston and slide valve.

9. **Accelerated Transmission of Emergency.**—The transmission rate in emergency with the "AB" valve is about 40 per cent. faster than that of the "K" brake. As the transmission time directly affects train-slack action, the time has been made as short as possible consistent with stability.

10. **Controlled Development of Emergency Brake-Cylinder Pressure.**—Investigations have shown that smooth and safe train-slack action can be accomplished either by a practically simultaneous application of all brakes in the train, or by controlling the development of brake-cylinder pressure on a somewhat longer time basis than that employed with the "K" brake, and this method is employed with the "AB" brake.

With this brake equipment the developement of brake-cylinder pressure occurs in three stages: (1) a rapid build-up to about 15 pounds in order to bring the brake shoes quickly into firm contact with the wheels; (2) the pressure builds up slowly during the slack adjustment period; (3) the pressure is increased rapidly to its maximum value. The delay in the development of brake-cylinder pressure is solely to permit of a smooth adjustment of the train slack. After a partial service application the delay time is shortened, depending upon the brake-cylinder pressure already developed. Thus, with an emergency application after a service brake-pipe reduction of 13 pounds, there will be no delay time in developing a maximum brake-cylinder pressure of 60 pounds from an initial pressure of 70 pounds.

11. High Brake-Cylinder Pressure in Emergency.—The high brake-cylinder pressure in emergency is obtained by using

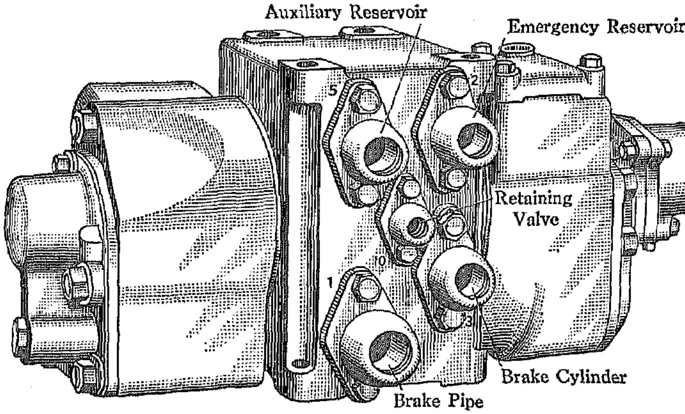


FIG. 1

an additional reservoir, namely, the emergency reservoir with a volume $1\frac{1}{2}$ times that of the auxiliary reservoir. This volume is employed to develop a brake-cylinder pressure in emergency of 60 pounds, or 20 per cent. greater than in full service.

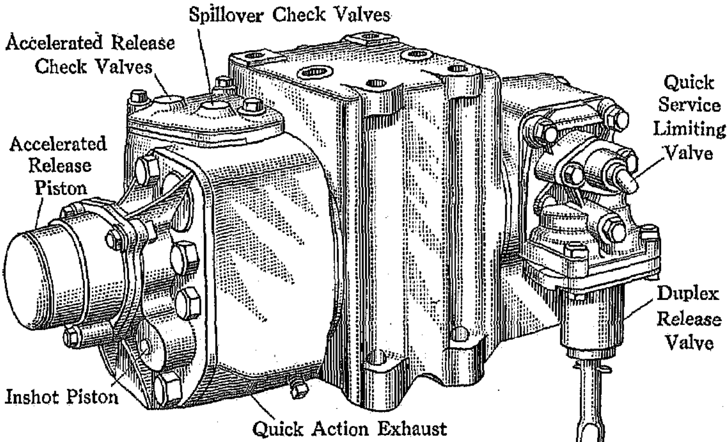


FIG. 2

12. Positive Release After Emergency Application.—After an emergency application, the rate of build-up of brake-pipe

pressure is hastened by discharging, during a fixed period of the release operation, the air in the brake cylinder and in the auxiliary reservoir into the brake pipe. The partial restoration of brake-pipe pressure from this source assists materially in the accomplishment of a prompt and positive release.

13. **Restricted Release of Brake-Cylinder Pressure.**—The release rate of all brakes with this equipment is the same as the retarded release rate of the "K" brake. This insures, during a release of the brakes on a moving train, a sufficiently slow rate of reduction in brake-cylinder pressure on the head cars to develop a slow and therefore a safe running out of slack. This feature permits the safe release of the brakes on moving trains, in many cases at speeds not possible with the "K" brake.

DESCRIPTION OF "AB" VALVE

GENERAL FEATURES

14. **Purpose.**—The purpose of the "AB" valve is to control the admission of the air to the brake cylinder and the exhaust of the air from it as well as to charge the reservoirs. This valve corresponds in a general way to the triple valve as used with former equipments.

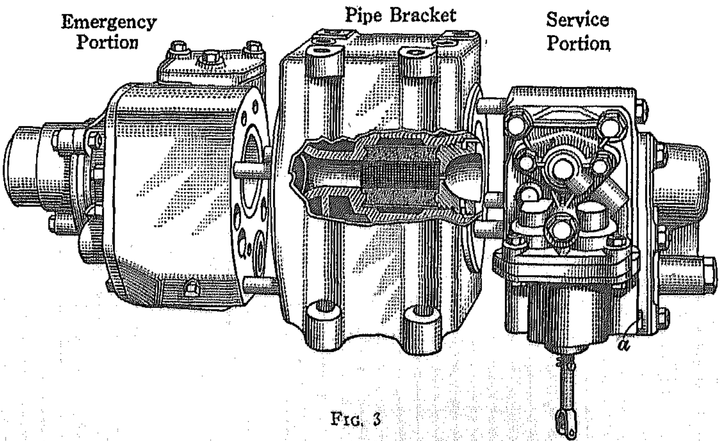


FIG. 3

15. **Names of Portions.**—A view of one side of the "AB" valve that shows the reinforced flange-union type of pipe con-

nections used is shown in Fig. 1, a view of the other side of the valve is shown in Fig. 2, and in Fig. 3 the portions are shown separated from the pipe bracket, here sectioned to show the strainer. The valve consists of three principal portions: a pipe bracket, a service portion, and an emergency portion.

16. Pipe Connections.—The various pipes are all connected to the pipe bracket and, as this bracket is permanently bolted to the car and has no moving parts, the pipe connections need not be disconnected when the valve is removed for repairs or cleaning. The openings to which the different pipes are connected are indicated in Fig. 1; the openings are marked for the information of workmen by figures cast on the bracket.

SERVICE PORTION

17. Purpose.—The purpose of the service portion of the "AB" valve is to control either directly or through the medium of the emergency portion the desired charging of the reservoirs and the service application and release of the brakes.

18. Parts of Service Portion.—The service portion, Plate 1, contains the following parts: The service piston *33*, the service graduating valve *34*, the service slide valve *36*, the service piston return spring *43* and cage, the stabilizing spring *39* and the spring guide *40*, the release-insuring valve *75*, the limiting-valve check *64a* and diaphragm *47*, the back-flow check *64*, the duplex release valves, *69* and *69a* with a handle *72*, the preliminary quick-service choke plug *31*, and the secondary quick-service choke plug *32*, the release-insuring choke plug *79*, the release and application by-pass check-valves *48a* and *48* and the release-insuring diaphragm *45*. This portion also contains a space known as the quick-service volume.

19. View of Slide Valve.—A view of the graduating valve and the slide valve, as well as a view of the part of the bush that forms a seat for the slide valve, are shown in Fig. 4. The various ports and passages are lettered to correspond with the reference letters shown on the charts in the back of this lesson paper.

It will be noted that the ports *c5, b6, e4,* and *q* extend entirely through the slide valve; port *F* also passes entirely through the valve. Cavity *B* is merely a cavity in the face of the slide valve, and cavities *D* and *C* are connected by an interior passage.

PURPOSE OF PARTS, SERVICE PORTION

20. **Service Piston 33.**—The purpose of the service piston *33* is to move the service graduating valve and the service slide valve when the brake-pipe pressure is varied, and to open and close the feed grooves.

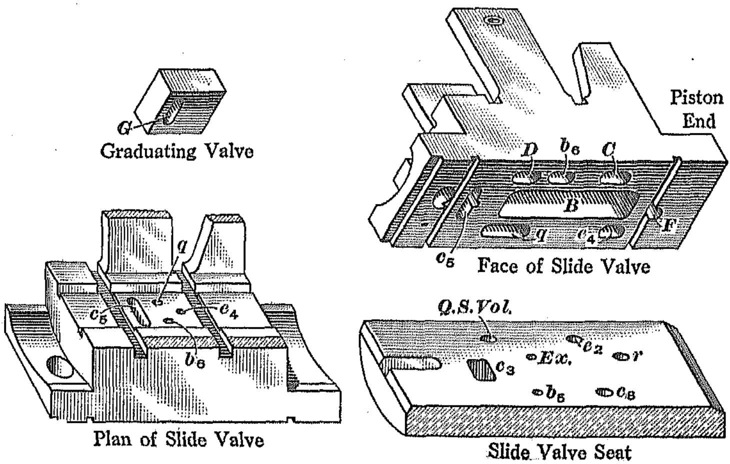


Fig. 4

21. **Service Graduating Valve.**—The service graduating valve opens and closes the passages (*a*) between the auxiliary reservoir and the emergency reservoir with the slide valve in release position; (*b*) from the brake pipe to the quick-service volume with the slide valve in full release position; (*c*) from the auxiliary reservoir to the brake cylinder with the slide valve in service position.

22. **Service Slide Valve.**—The service slide valve 36 opens and closes the ports and passages (*a*) between the auxiliary (service slide valve chamber) and emergency reservoirs past the graduating valve; (*b*) from the brake pipe to the quick-service volume through the graduating valve; (*c*) from the

brake pipe through the limiting valve to the brake cylinder; (*d*) from the brake cylinder to the pressure-retaining valve; (*e*) from the auxiliary reservoir past the graduating valve to the brake cylinder; (*f*) from the auxiliary reservoir to the inner area of release-insuring valve; (*g*) from the inner area of the release-insuring valve to the pressure-retaining valve.

23. **Service-Piston Return Spring 43 and Cage.**—The purpose of the return spring *43* is to prevent the movement of the service piston to retarded-recharge position unless the pressure in the brake pipe is about 3 pounds higher than that in the auxiliary reservoir.

24. **Stabilizing Spring 39 and Spring Guide 40.**—The purpose of the spring *39* and guide *40* is to provide stability of quick-service activity by preventing movement of the service piston to preliminary quick-service position until a predetermined difference in pressure between the brake pipe and the auxiliary reservoir is attained.

25. **Release-Insuring Valve 75.**—The purpose of the valve *75* is to insure the return of the service piston to release position in case of excessive friction of the slide valve, by exhausting auxiliary-reservoir pressure to the atmosphere, the adjusting nut within the cap nut that houses the release-insuring-valve spring is used to place the correct tension of 1½ pounds on this spring when the assembly is made at the factory.

26. **Limiting Valve Check 64a and Diaphragm 47.**—The purpose of the limiting valve check *64a* and diaphragm *47* is to terminate the first stage of service when a predetermined brake-cylinder pressure is developed.

27. **Back-Flow Check 64.**—The check *64* serves to prevent the flow of brake-cylinder pressure into the brake pipe, such as during emergency when the brake-cylinder pressure is higher than the brake-pipe pressure.

28. **Duplex Release Valve.**—The handle of the duplex release valve controls the opening of the auxiliary reservoir release valve *69* and the emergency release valve *69a*, thereby

permitting manual reduction or the draining of auxiliary reservoir air alone or both reservoirs together.

29. **Quick-Service Volume.**—The brake-pipe air flows into the quick-service volume to initiate preliminary quick service throughout the train as well as to move the valves that are venting into service position.

30. **Preliminary Quick-Service Choke Plug 31.**—The purpose of the choke plug *31* is to restrict the continuous exhaust of quick-service volume air to the atmosphere and thereby insure that a slide valve with abnormal friction is moved to service position.

31. **Quick-Service Choke Plug 32.**—The purpose of the choke plug *32* is to restrict the rate of flow of air from the brake pipe to the brake cylinder during the first stage of service.

32. **Release-Insuring Choke Plug 79.**—The purpose of the choke plug *79* is to restrict the rate of auxiliary reservoir reduction at such time as the release-insuring-valve functions to reduce this pressure.

33. **Release and Application By-Pass Check-Valves 48a and 48.**—The check-valves *48a* and *48* by-pass brake-pipe air around the strainer in case the strainer is restricted.

EMERGENCY PORTION

34. **Purpose.**—The purpose of the emergency portion of the "AB" valve is to control the quick-action feature, the controlled high brake-cylinder pressure, and the accelerated-emergency-release function.

35. **Parts of Emergency Portion.**—The emergency portion, Plate 1, contains the following parts: The emergency piston *116*; the emergency graduating valve *133*; the emergency slide valve *115*; vent-valve piston *107* and vent valve *111*; emergency-piston return spring *137* and cage; emergency-piston spring *131* and spring guide *130*; accelerated-release piston *144* with springs *150* and *151*, and stem *148*; spillover check-valve *97* and ball check *95*; accelerated-release check-valve *93*, and ball check *94*;

diaphragm *99*; diaphragm spring *101* and slide-valve strut *103*, inshot piston *117* and inshot valve *126*; inshot-piston spring *124*; inshot-valve spring *125*; delay choke plug *127*; timing valve *161*; timing choke plug *153*; inshot-piston volume; choke plug *140*; charging choke plug *138*; choke plug *109*.

36. **Views of the Slide Valve.**—The slide valve and the graduating valve, as well as the part of the bush that forms a seat for the slide valve are shown in Fig. 5. The various ports

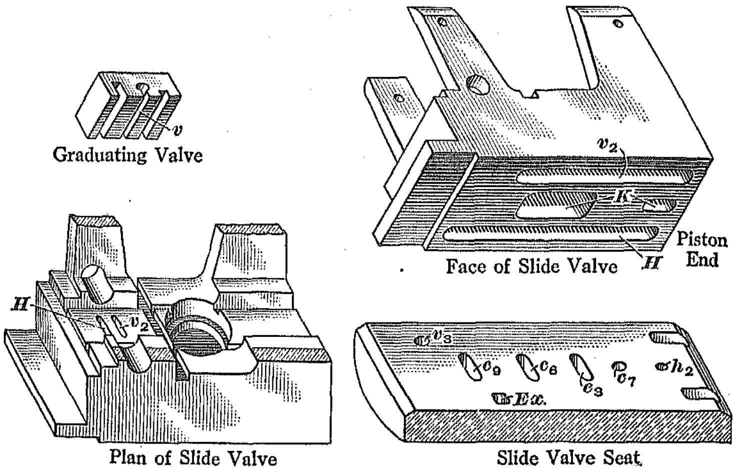


Fig. 5

and passages are lettered to correspond with the reference letters shown on the charts in the back of this lesson paper. It will be noted that cavity *H* in the face of the slide valve is connected by an interior passage to a port *H* in the top of the valve. Also, cavity *v2* is connected by an interior passage to a port *v2* in the top of the valve. Cavities *K* are two connected cavities in the face of the slide valve.

PURPOSE OF PARTS, EMERGENCY PORTION

37. **Emergency Piston 116.**—The emergency piston *116* moves the graduating valve *133* when a service rate of brake-pipe reduction is made, and also the slide valve when an emergency rate of reduction is made.

38. **Emergency Graduating Valve 133.**—The valve *133* controls the flow of air from the quick-action chamber to the atmosphere during service applications, and from the quick-action chamber to the vent-valve piston *107* during emergency applications.

39. **Emergency Slide Valve 115.**—The emergency slide valve controls the flow of air (*a*) from the quick-action chamber through the graduating valve to the atmosphere during service applications; (*b*) from the quick-action chamber to the vent-valve piston *107* during emergency applications; (*c*) from the quick-action chamber to the outer face of the accelerated-release piston *144* except during emergency applications; (*d*) from the emergency reservoir to the outer face of the accelerated-release piston *144* during emergency applications; (*e*) from the emergency reservoir to the brake cylinder during emergency applications; (*f*) from the brake cylinder past check-valves *93* and *94* to the brake pipe during a release after an emergency; (*g*) from the brake cylinder through the inshot-piston volume to the outer face of inshot piston *117* except during emergency.

40. **Piston 107 and Vent Valve 111.**—The purpose of the piston *107* and valve *111* is to vent brake-pipe air to the atmosphere during an emergency application.

41. **Emergency Piston Return Spring 137 and Cage.**—The purpose of the spring 137 is to return, during release cycles, the emergency piston from accelerated release to normal release position when the quick-action-chamber pressure recharges to approximately brake-pipe pressure.

42. **Emergency Piston Spring 131 and Spring Guide 130.** The spring *131* and spring guide *130* stabilize the emergency portion against undesired emergency.

43. **Accelerated-Release Piston 144 with Springs 150 and 151 and Stem 148.**—The piston *144* with springs and stem prevent the return of the emergency piston to release until a predetermined brake-pipe pressure has been restored.

44. **Spillover Check-Valve 97 and Ball Check 95.**—The check-valve *97* and ball check 95 open and dissipate any over-

charge of the quick-action chamber into the emergency reservoir during full release position of the brake valve, and they prevent a reverse flow at such times as the emergency-reservoir pressure is higher than that in the quick-action chamber. The flow of air through these valves from the quick-action chamber to the emergency reservoir accelerates the initial charging of this reservoir.

45. Accelerated Release Check-Valve 93 and Ball Check 94. The check valve *93* and the ball check *94* prevent the flow of air from the brake pipe to the brake cylinder if for any reason the emergency slide valve is forced to accelerated release position at times when the brake-cylinder pressure is lower than the brake-pipe pressure. The port in the emergency slide-valve seat that leads to the check-valves is blanked by the slide valve in normal charging position of the emergency piston. It is through these valves that the air flows from the combined volumes of the brake cylinder and the auxiliary reservoir to the brake pipe during a release after emergency.

46. Diaphragm Spring 101 and Slide-Valve Strut 103. The spring *101* and strut *103* serve to keep the slide valve seated in the absence of pressure in the quick-action chamber.

47. Inshot Piston 117 and Inshot Valve 126.—The piston *117* and valve *126* control the development of the first stage of emergency brake-cylinder pressure.

48. Delay Choke Plug 127.—The choke plug *127* provides the delayed build-up of brake-cylinder pressure during the development of the second stage of emergency brake-cylinder pressure.

49. Timing Valve 161.—The timing valve starts the final stage of the development of emergency brake-cylinder pressure.

50. Timing Choke Plug 153.—The purpose of the choke plug *153* is to restrict the rate of flow of air to the brake cylinder through the additional port opened by the timing valve during the development of the final stage of emergency brake-cylinder pressure.

51. Inshot-Piston Volume.—The inshot-piston volume serves to annul the development of the controlled brake-cylinder pressure during a service-brake application and modifies the controlled build-up when service precedes an emergency application.

52. Choke Plug 140.—The choke plug *140* serves to prevent the slamming of the accelerated-release piston to its innermost position or extreme left position by restricting the flow of air displaced by this piston.

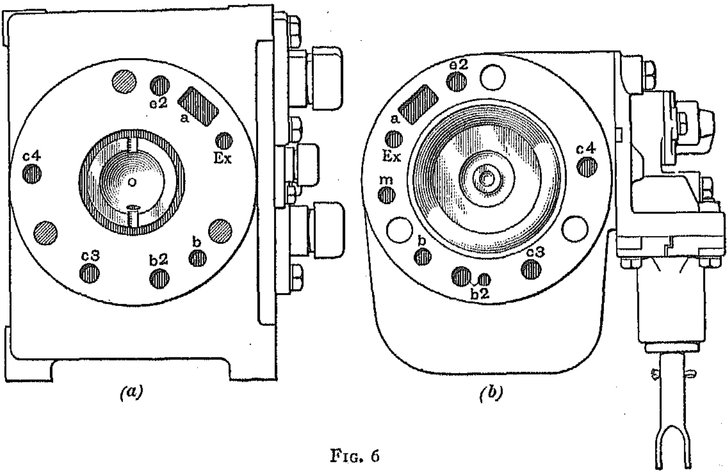


Fig. 6

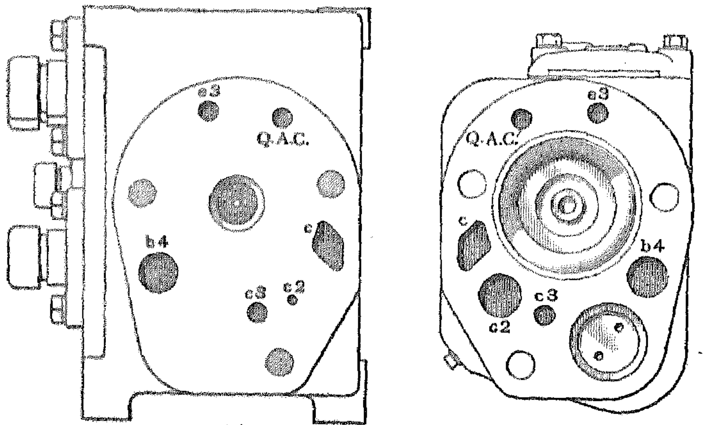
53. Charging Choke Plug 138.—The charging choke plug *138* restricts the rate of flow of air from the brake pipe to the quick-action chamber.

54. Choke Plug 109.—The choke plug *109* in the vent piston *107* controls the rate of exhaust of quick-action-chamber air during emergency.

PIPE BRACKET

55. Purpose.—The pipe bracket to which the service and the emergency portions are bolted provides a means of securing the "AB" valve to the underframing of the car. All pipe connections are made permanently to the bracket by means of reinforced flanged unions so that no pipe joints need to be dis-

turbed when removing or replacing the operating portions of the valve. The bracket contains a removable hair strainer and the quick-action chamber.



(a) (b)

FIG. 7

56. Bolting Faces.—The face of the pipe bracket to which the service portion is bolted is shown in Fig. 6 (*a*) and the bolting face of this portion is shown in (*b*). The face of the pipe bracket to which the emergency portion is bolted is shown in Fig. 7 (*a*) and the bolting face of this portion is shown in (*b*).

TWO-COMPARTMENT RESERVOIRS

57. Two types of reservoirs have been designed for the "AB" brake equipment, one of welded-steel construction and one of cast metal shown in Plate 11. The cast-metal reservoir is made up of three castings, namely a separation plate and two flanged chambers, the latter being identical, except that one is provided with a single supporting lug and the other with two. The position of the separation plate between the chambers when assembling determines which chamber is the auxiliary-reservoir volume and which is the emergency-reservoir volume as indicated by letters cast on a lug projecting from the separation plate between the pipe connections. The letters

AUX on one side of the lug indicate that the compartment on that side is the auxiliary reservoir and the letters *EMERG* on the other side of the lug indicate that the emergency-reservoir volume is on that side. The volume of the auxiliary reservoir is such that with the brake system charged to 70 pounds, a full service application will result in the equalization of the auxiliary-reservoir and brake-cylinder pressures at about 50 pounds. The emergency reservoir is of such a volume that with the equipment charged to 70 pounds, the volumes of both reservoirs and the brake cylinder will equalize at about 60 pounds during an emergency application.

The auxiliary reservoir has a volume of 2,500 cubic inches and the emergency reservoir a volume of 3,500 cubic inches.

BRAKE CYLINDER

58. A sectional view of the 10″×12″ brake cylinder used with the "AB" brake equipment is shown in Fig. 8. The pipe from the "AB" valve is connected to the brake cylinder at the

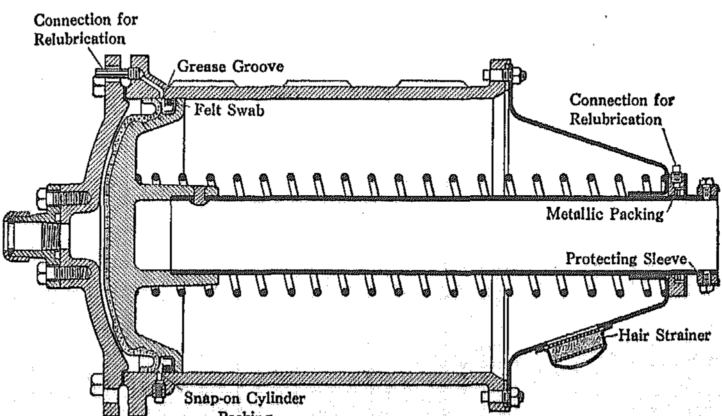


Fig. 8

side of the lever bracket by a ¾-inch reinforced flanged union, although the bracket cylinder is also supplied with a plain pressure head with the pipe connection in the center. The piston has a hollow sleeve in which is inserted a loose push rod, not shown, that is connected to the levers and rods of the foundation brake

rigging. This arrangement permits the brake to be applied by the hand brake without having to draw out the piston. A release spring is used to return the piston to the release position shown.

To prevent dirt from entering the cylinder, the piston rod is ground true and the non-pressure head is fitted with three metallic packing rings, lubricated through a tapped opening normally closed by the plug shown. The curled hair strainer on the non-pressure head, permits air to enter the cylinder during the release movement. It is held in place by a breather cover, which prevents flying dirt and water from coming into contact directly with the strainer.

The piston and the cylinder are lubricated through the tapped openings at the rear, one at the top and one at the bottom, and these openings are so located as to deliver lubricant into a groove in the piston behind the packing cup and the felt swab. The purpose of the felt swab is to prevent an overflow from the groove to the non-pressure side of the piston when introducing the lubricant. Also, it serves to lubricate the cylinder for each application and release movement of the piston. The packing cup, which is of the "snap-on" type, is formed to fit the piston, and lies flat against its face, a follower plate not being necessary as with other standard brake cylinders. The cup is held in place by being fitted over a shoulder machined on the piston.

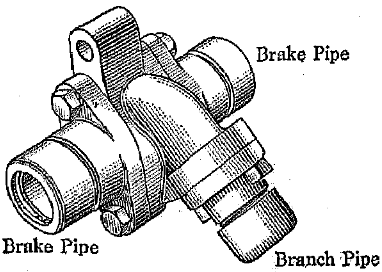


FIG. 9

BRANCH-PIPE TEE

59. The branch-pipe tee is shown in perspective in Fig. 9. It is a fitting used to connect the branch pipe to the brake pipe and its purpose is to prevent excessive moisture that may be deposited in the brake pipe from passing into the branch pipe and thence into the "AB" valve. The centrifugal dirt collector effectively collects dirt and moisture from the branch pipe, but the use of the branch-pipe tee assists in doing so.

The interior of the tee is such that the passage that leads to the branch pipe comes out of the top of the brake pipe; the air from this pipe then flows upwards into the branch pipe, while the moisture and heavy particles of dirt pass on through the brake pipe. The pipe connections are made by means of reinforced flanged unions, and a supporting lug, as shown, is provided for bolting the tee to the car underframing.

COMBINED DIRT COLLECTOR AND CUT-OUT COCK

60. With the "AB" equipment, the dirt collector and the cut-out cock, instead of being installed in the branch pipe as two parts, are combined in one part as shown in Fig. 10, which shows the dirt-collector portion sectioned. The dirt collector protects the "AB" valve against the entrance of dirt. The cut-

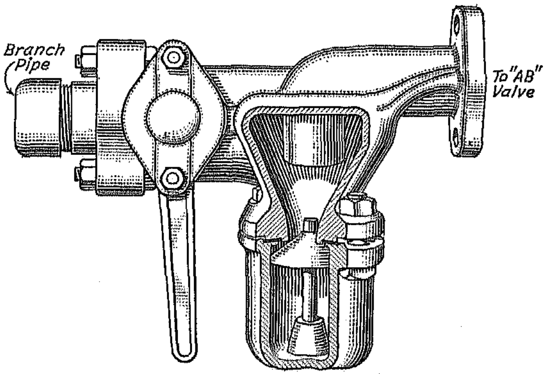


FIG. 10

out cock with the handle vertical opens communication between the valve and the branch pipe, and with the handle horizontal closes one from the other. Bolting flanges are provided for both pipe connections; the flange on the dirt-collector end bolts direct to the "AB" valve pipe bracket, while the flange on the cock end is provided with a reinforced flange union.

The purpose of the umbrella-shaped check-valve in the dirt collector is to hold in the dirt chamber the dirt that is collected under all conditions of air-brake operation. The body portion has a machined seat against which the check-valve seats when a

heavy reduction occurs above it, as during an emergency application, thereby shutting off communication between the dirt chamber and the collector outlet. The check-valve is so designed and placed on the valve stem as to permit of a rocking motion so that any fine dust which may collect on top of the check-valve will be shaken off into the dirt chamber.

FLANGED-UNION CONNECTION AND FLANGED PIPE UNION

61. A view of the flanged-union connection as used on the "AB" valve, the brake cylinder, the reservoir, the dirt collector, and the branch-pipe tee is shown in Fig 11. It comprises a union flange *a*, a Wabco gasket, a clamping nut, and an anchor ring.

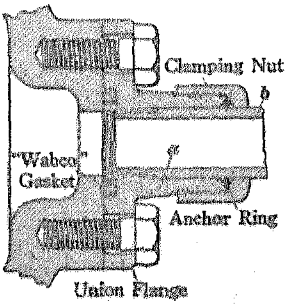


FIG. 11

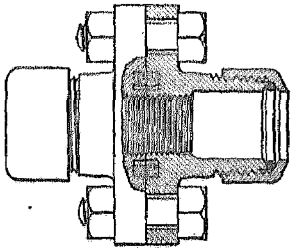


FIG. 12

The pipe *b* is screwed into the union flange as shown. Tightening the clamping nut will cause the anchor ring to close in and grip the pipe firmly so that all bending strains are removed from the weakest point and concentrated at its strongest point. A flanged pipe union used to connect together the adjacent ends of two pipes is shown in Fig. 12. This type of union supersedes the sleeve type of union previously used.

OPERATION OF THE EQUIPMENT

FULL RELEASE AND CHARGING POSITION

62. The passage of air through the "AB" valve in full release and charging position is shown in the diagrammatic view of this valve shown in Plate 1. Air from the brake pipe flows through the combined dirt collector and cut-out cock to passage *b* and thence through the curled hair strainer *6* to the faces of both

the service piston 33 and the emergency piston *116*. The air passes the service piston through the two feed grooves shown and then flows through passage *a* to the auxiliary reservoir and through the restricted passage *e4* in the service slide valve to passages *e2* and *e* to the emergency reservoir. Brake-pipe air on the face of the emergency piston *116* flows through the charging choke *138* to the slide-valve side of the piston and to the left side of the timing valve *161*; brake-pipe air also flows to the quick-action chamber. A branch passage *e5* conveys emergency reservoir air to the top of the check-valve *97* and should the quick-action chamber, which also includes the chamber behind the emergency piston *116*, charge through the restricted choke *138* faster than the emergency reservoir charges, the spillover checks *95* and *97* will lift and permit quick-action-chamber air to flow to the emergency reservoir at a restricted rate. Thus, an emergency application will be prevented through the undesired operation of the emergency portion in the event of the quick-action chamber becoming overcharged, as might occur on the head end of a long train. Any tendency of the air in passage *e3* to unseat the emergency slide valve in the event of an undercharged quick-action chamber is prevented by the spring *101* and the diaphragm loaded strut *103*, the top of which is in communication with the emergency-reservoir pressure in passage *e5* through passage *e6*. With the quick-action chamber fully charged, the air pressures are balanced on the diaphragm, leaving the light pressure of the spring alone to act on the strut *103*.

The brake cylinder is connected through passage *c*, past inshot valve *126*, passages *c2* and *c3*, cavity *B* in the service slide valve and passage *Ex* to the retainer. The inshot-piston volume, the chamber on the outside of the inshot piston, and the chamber on the inside of the timing valve are connected to passage *c7*, cavity *K* of the emergency slide valve passage *c6*, and passage *c3*, and to the retainer as just explained.

As passage *c4* is connected to passage *c3*, the spring *63* will force the diaphragm *47* downwards, thereby unseating the quick-service limiting-valve check *64a*. A branch *b4* from the brake-pipe passage *b* leads to the right of the quick-action vent valve *111*, and also to the top of the accelerated release check *93*.

The air in the quick-action chamber is connected through port *h* in the emergency slide valve to passage *h2*, which leads to the left of the accelerated release piston *144*. The right side of this piston is also exposed to the pressure in the quick-action chamber, hence the piston is balanced and remains in its position to the extreme left as shown.

63. Should the strainer *6* be obstructed by dirt and thus prevent the free passage of air through it, the air will pass through the passage *b*, then unseat the by-pass check-valve *48a* and pass through passage *b2* to the chamber in front of the service piston. If the brakes are being applied and the strainer is partly obstructed, the pressure will reduce in passage *b*, then the higher pressure in passage *b2* will unseat by-pass check-valve *48* and flow to passage *b*. A difference in pressure of 2 pounds across the strainer will cause the check-valves to operate.

The passage *m* shown in Plate 1 is for the purpose of providing auxiliary-reservoir air to the transfer valve, used with the 4-12 brake equipment on heavy cars.

RELEASE AND RETARDED RECHARGE POSITION

64. If during a release the brake-pipe pressure in the chamber in front of the service piston becomes more than approximately 3 pounds higher than the pressure in the auxiliary reservoir, the service piston, the slide valve, and the graduating valve will be forced to the right, and the return spring 43 will be compressed. The "AB" valve will then assume retarded recharge position as shown in Plate 2. The movement of the piston closes one of the feed grooves and reduces the flow of the air from the brake pipe to the auxiliary reservoir by confining it to the upper feed groove. As the valves on the front end of the train assume retarded recharge position, and full release and charging position on the rear portion, the slow recharge of the auxiliary reservoirs is confined to the front part of the train only or on about the first 25 cars. Hence, the pressure in the brake pipe and in the auxiliary reservoirs is built up on the rear portion of the train at an increased rate, thus providing a sufficiently uniform recharge. The restricted recharge

of the auxiliaries on the forward portion of the train also tends to prevent an overcharge of these reservoirs. The brake cylinder is connected to the exhaust through ports of the same size as in full release position so that the rate of release will be the same in both positions or the release, from 50 pounds to 5 pounds, will occur in about 22 seconds. This corresponds to the release time of the "K" triple in retarded release. The slide valve blanks port *b5*, and prevents the graduating valve from being blown off the seat during the initial charging of the reservoirs.

65. The uniform release feature of the "K" triple valve, namely, a slow discharge of brake-cylinder air on about the first 25 cars and a more rapid discharge on the other cars, is not incorporated in the "AB" valve. This feature was ideal for trains up to 70 cars, which represented the maximum train lengths when the "K" valve was introduced, but it would be inadequate for long trains. While 25 cars in retarded-release position on the front of a train of 70 cars are sufficient to produce a gradual readjustment of slack, yet this number on a train of 150 cars would be inadequate.

Instead of using a uniform release feature, the time required to vent brake-cylinder air is lengthened to 22 seconds. This in combination with a movement of the service portion to release position, whenever the brake-pipe pressure has been increased 1½ pounds above the auxiliary-reservoir pressure insures, during a release of moderate service applications on a moving train, a sufficiently slow rate of reduction in brake-cylinder pressure to develop a slow and therefore a safe, running out of slack.

PRELIMINARY QUICK-SERVICE POSITION

66. Transmission of Quick Service.—The cause of shocks in long freight trains is principally due to the differences in the speed between the head and the rear ends of the train. These differences are developed during the early stages of the brake application by the brakes on the head end becoming effective sooner than those on the rear end. This consequent difference in speed is effected by the rate of propagation of the brake application and by the rate of development of the brake-cylinder pres-

sure on each car and locomotive. Hence, in order to keep within tolerable limits the shocks that result from the difference in speed between the front and the rear ends of long trains, an initial service application of the brakes should be transmitted through a long train as rapidly as possible. This is accomplished with the "AB" valve by so designing the service portion that it will assume preliminary quick service with a relatively low difference in pressures. It follows from this that serial quick-service action can be produced by a small quick-service volume, and a small volume implies that it will be filled at a rapid rate, therefore bringing about rapid serial quick service. The slight difference in pressures required to start the service piston is due to the fact that it has only to move the graduating valve. The resistance offered by the stabilizing spring plus the frictional resistance offered by the piston and the graduating valve under normal conditions is such that a difference of pressures across the piston of about .8 pound will compress the spring to a point where quick-service venting will occur.

With a train of 150 cars, quick service, with a development of a brake-cylinder pressure of about 10 pounds, will be transmitted through the train in about 15 seconds.

67. **Explanation of Preliminary Quick Service.**—The "AB" valve is shown in preliminary quick-service position in Plate 3. When a service brake-pipe reduction is made, the pressure also reduces in front of the service piston *33*, and it and the graduating valve are accordingly moved to the left by the pressure in the auxiliary reservoir until the stabilizing stem *40* in the end of the service piston engages the right-hand end of the slide valve. The slide valve provides a positive stop for the movement of the piston and the stabilizing spring *39* will be compressed, after a sufficient reduction has been made. The initial movement of the piston closes the feed grooves, and the graduating valve blanks the emergency-reservoir charging port in the slide valve, thereby isolating the emergency reservoir from the auxiliary reservoir.

A continuation of the service brake-pipe reduction brings about the required difference in pressure on the piston to compress the

stabilizing spring *39* and allow the service piston and the graduating valve to move into preliminary quick-service position as shown. Air from the brake pipe now passes from passage *b5* to passage *b6* in the slide valve, thence through cavity *G* in the graduating valve to passage *q* and thence to the quick-service volume. The quick-service volume has a capacity of 35 cubic inches, and the local reduction caused by the equalization of the brake pipe into this volume is rapid enough to transmit quickly the serial reduction to following valves, and is sufficient in amount to cause a slide valve with normal friction on which the venting occurs to assume service position. In this position a further flow of air to the quick-service volume is prevented. Should a valve have abnormal friction through service use, it will eventually be moved to service position because the controlled vent port *31* from the quick-service volume continues the local brake-pipe reduction until the proper difference in pressures is produced to move the valve to service position.

After the quick-service volume has been cut off by the movement of the slide valve to service position, the pressure in this volume is exhausted through choke *31*. In service position, the service piston makes an air-tight joint on the gasket in front of the piston.

During preliminary quick service, the emergency piston *116* and the graduating valve move to service position as explained later, under service position.

SERVICE POSITION (FIRST STAGE)

68. Explanation.—It was shown when considering preliminary quick service that the service portion of each "AB" valve was moved rapidly to service position owing to the venting of brake-pipe air to the quick-service volume. The first stage of service, which will now be considered, terminates with the development of a brake-cylinder pressure of about 10 pounds, or the pressure at which the limiting valve closes. However, owing to the force required to move the piston and the members of the foundation-brake gear, only about 6 pounds is effective at the brake shoes. This pressure is sufficient to collect the train slack without severe shocks.

When the service slide valve *36* is in service position, Plate 4, air *from the auxiliary reservoir* passes *by the graduating valve* to the brake cylinder, also air from the brake pipe flows at a restricted rate through the limiting valve to the brake cylinder, until a pressure of about 10 pounds is obtained. The flow of air from the brake pipe then stops and the first stage of service terminates. The further development of brake-cylinder pressure during service reductions is brought about by the air from the auxiliary reservoir alone, until a final release is made.

69. The following explains the first stage of service in more detail: With the service piston and attached valves in service position, brake-pipe air flows from passage *b5* through port *C* and cavity *D* in the service slide valve, thence through passage *c8* and choke *32*, and lifts the back-flow check *64* against the tension of spring *57*. The air now flows past the limiting-valve check *64a*, which prior to this has been kept unseated by the action of spring *63* on the diaphragm *47*, and then passes to the under side of the limiting diaphragm *47* to passage *c4*, *c3*, and *c2*, thence past the unseated inshot valve *126* to passage *c* and to the brake cylinder.

The air from the auxiliary reservoir flows past the right-hand end of the graduating valve and through passages *c5* and *c3*, thence by way of the inshot valve to the brake cylinder as just described.

As the pressure in the brake cylinder increases owing to the inflow of air from the brake pipe and the auxiliary reservoir, a like increase occurs beneath the quick-service limiting diaphragm *47*. When the pressure in the brake cylinder reaches approximately 10 pounds, the diaphragm is deflected upwards against the tension of spring *63*, then the spring *57* seats the valve *64a* and also the valve *64* as shown in the separate view of these parts at the right of Plate 4. With valve *64a* closed, the flow of air from the brake pipe to the brake cylinder stops and the first stage of service terminates, unless there is brake-cylinder leakage.

The inshot valve remains open because the air on its way to the brake cylinder passes through passage *c6* and cavity *K* in the emergency slide valve to passage *c7*, to the inshot piston

volume, and thence to the back of the inshot piston *117*. As the brake-cylinder pressure is also acting on its other side and as the inshot-piston spring *124* is stronger than the inshot-valve spring *125*, the inshot valve is held in open position.

70. The foregoing shows that the action of the engineer's brake valve is only to start quick-service venting on the forward cars. Theoretically, a brake-pipe reduction of about 3 pounds will bring this action about; ordinarily, however, a reduction of about 7 pounds is made. The reason is that the operation of the "AB" valves will produce such a reduction in any event so that it is just as well to make a reduction of this amount at the brake valve. After quick service venting starts, each "AB" valve operates to produce locally the required reduction to insure at least 10 pounds brake-cylinder pressure on this car, regardless of the piston travel or a reasonable amount of brake-cylinder leakage. Hence, the development of the initial brake-cylinder pressure of 10 pounds is beyond the control of the engineman. A heavier brake-pipe reduction will be required to produce a brake-cylinder pressure of 10 pounds when the piston travel is longer than 8 inches and a lesser reduction if the piston travel is less. However, the required increase or decrease in the brake-pipe reduction to compensate for the difference in piston travel is automatically produced by the "AB" valve in the first stage of service.

During the initial quick-service reduction, the length of the exhaust at the service exhaust port of the brake valve will be short because the main portion of the reduction is produced by the "AB" valves. On the following reductions all the brake-pipe air must be discharged at the brake valve until a release is made, and this produces a long exhaust at the exhaust port.

71. When applying and releasing the brakes on descending grades, and the brake is applied with the retainer in holding position, preliminary quick service alone is obtained; that is, brake-pipe air is discharged only to the quick-service volume and to the atmosphere. The first stage of service, namely, the flow of brake-pipe air to the brake cylinder does not occur because the quick-service limiting valve closes and prevents this

action when a pressure of 10 pounds or more has been developed in the brake cylinder. Therefore preliminary quick service and the two stages of service occur only during the first reduction.

SERVICE POSITION (SECOND STAGE)

72. Explanation.—The first stage of service was terminated by the closing of the limiting valve. After this valve closes, the air from the auxiliary reservoir will continue to flow to the brake cylinder by the right-hand end of the graduating valve and through passage *c5* and *c3* and thence by way of the inshot valve to the brake cylinder as shown in Plate 4.

The reduction in pressure in front of the emergency piston that follows the venting of brake-pipe air to the quick-service volume in preliminary quick service will result in this piston being moved forwards by the higher pressure in the quick-action chamber. The graduating valve moves with the piston until the emergency stabilizing stem *130* engages the left end of the emergency slide valve, Plate 4. The charging choke *138* is now closed, and port *v* in the graduating valve is in register with port *v2* in the slide valve, which in turn is connected to the exhaust. With the ports registering with the exhaust as just described, the flow of air from the quick-action chamber to the atmosphere keeps pace with the normal service rate of brake-pipe reduction. However, if this rate is slightly exceeded a sufficient difference of pressures will be created on the emergency piston to cause it to partly compress the spring *131* until the graduating valve has moved to a position where it uncovers port *H*; in this event an emergency application would occur. By this means the valve is stabilized against undesired emergency; however, an emergency application is made available at any time.

SERVICE LAP POSITION

73. After the discharge of brake-pipe air stops at the brake valve, and the "AB" valves, the air will continue to flow from the auxiliary reservoir to the brake cylinder until the auxiliary-reservoir pressure is reduced slightly below the pressure in the brake pipe. When this happens, the service piston will move the graduating valve to the right until the stem of the piston

engages the slide valve. In this position the graduating valve blanks the service port *c5* in the slide valve and prevents the further flow of auxiliary-reservoir air to the brake cylinder.

The emergency piston *116* and the graduating valve return to charging position and this valve blanks port *v2* in the slide valve, thereby preventing a further flow of quick-action-chamber air to the exhaust port. In service lap position, the brake pipe is connected through a cavity in the service slide valve to the limiting valve so that brake-pipe air will flow to the brake cylinder in the event that leakage from the brake cylinder reduces its pressure below the tension of the limiting-diaphragm spring.

RELEASE AND RECHARGE AFTER SERVICE APPLICATIONS

74. The "AB" equipment is designed to insure a more positive and a more prompt release of all brakes than is possible with the "K" equipment. One condition that hindered the release of the brakes on the rear of long trains with the "K" equipment was the fact that the auxiliary reservoirs on the forward part of the train absorbed air from the brake pipe as soon as their triples moved to release position. Such a condition materially reduced the recovery of brake-pipe pressure, especially back of the first fifty or sixty valves. Even on trains of 150 cars little trouble is experienced in obtaining a prompt release of this number of valves; the difficulty is to obtain a release on the cars farther back.

Other factors that enter into a release of the brakes are triple-piston packing-ring leakage, and the resistance the triple slide valve frequently offers to the release movement.

75. In the design of the "AB" equipment, the foregoing conditions were taken into account and means were provided to overcome them in the following manner: (1) The air stored in the emergency reservoir is utilized to provide the initial recharge of the auxiliary reservoir locally, during which time no air is being drawn from the brake pipe so that brake-pipe pressure is developed more rapidly than otherwise on the rear of long trains. (2) A special diaphragm-operated valve known as the release-insuring valve is provided which functions to accom-

plish the release of each brake whenever the difference in pressures on the service piston exceeds $1\frac{1}{2}$ pounds. This provision takes care of packing-ring leakage and excessive slide-valve friction, whereas the first provision, namely, the utilization of emergency-reservoir air permits the brake-pipe pressure to be restored quickly on the rear of long trains. Therefore, all brakes will be released before any recharging from the brake pipe will cause an appreciable reduction in the rapid recovery rate of brake-pipe pressure. In other words, the actual recharging of the reservoirs from the brake pipe is postponed to a period when all brakes are released.

76. A detailed description of the operation of the "AB" valve in a release and a recharge after a service application is as follows: The pressure in the emergency reservoir remains at its initial pressure during service applications. When the service slide valve returns to release position, the equipment charges in the same manner as shown in Plate 1, except that air now flows from the emergency reservoir through passages *e*, *e2*, and restricted port *e4* in the slide valve to the service slide-valve chamber and passage *a* to the auxiliary reservoir. This inflow of air provides the quick-recharge feature and also insures, as already explained, a more positive and prompt release of all brakes by permitting a quicker build-up of brake-pipe pressure throughout the train than if all of the recharge was from the brake pipe. The air exhausts from the brake cylinder as already explained under Full Release and Charging Position and Release and Retarded Recharge Position. As soon as the pressure in the brake pipe becomes high enough, the auxiliary and the emergency reservoirs charge from the brake pipe either through two feed grooves or through one, depending upon whether the "AB" valve is in Release or Retarded Recharge Position.

77. The space surrounding the release-insuring valve as well as to the right of the release-insuring diaphragm *45*, Plate 4, is connected at all times to the service slide-valve chamber and hence to the auxiliary reservoir. The space to the left of the diaphragm *45* is subject to the brake-pipe pressure in the service-piston chamber. Also, with the service slide valve in service

and service lap positions, the space within the seat of the release-insuring valve is connected to the atmosphere through passage *r*, cavity *B* in the slide valve, and a passage that leads to the exhaust.

Now if, during a release, the service piston fails to move promptly to release position and when the brake-pipe pressure on the left of the release-insuring-valve diaphragm becomes one and one-half pounds higher than the auxiliary-reservoir pressure on the other side of the diaphragm, it will be deflected to the right and will unseat valve *75*. This valve when open will allow a restricted flow of auxiliary reservoir air to the atmosphere through passage *r*, choke *79*, and cavity *B* in the slide valve as already explained. The pressure in the auxiliary reservoir will now reduce until a sufficient difference of pressures is created on the service piston to move it and the slide valve to release position. The service slide valve then closes the connection between passage *r* and the exhaust and stops the further discharge of air. The release-insuring valve is in reality an automatic release valve upon each car and acts to bleed off each brake whenever the resistance to release movement exceeds a difference in pressures of 1½ pounds across the service piston. It is this maintenance of a constant difference in release pressure of less than 2 pounds which insures a prompt and certain release of each brake in the train regardless of the amount of the preceding application and irrespective of the development of abnormal frictional resistance to release movement. The release-insuring valve is shown in open position in Plate 2.

EMERGENCY POSITION (FIRST STAGE)

78. When the brake-pipe air in front of the service piston and the emergency piston is vented at an emergency rate, the air in the quick-action chamber cannot reduce through the ports *v* and *v2*, Plate 6, to the exhaust at the same rate. As a result, the pressure on the left side of the emergency piston becomes high enough to cause it to compress spring *131* and hence allow the graduating valve *133* to move far enough on the slide valve to uncover port *H*. The air from the quick-action chamber now passes through this port to passage *v3* and forces the vent valve piston *107* to the right, thereby unseating the vent valve *111*, which permits a

heavy and sudden discharge of brake-pipe air to the atmosphere. This action on one car brings about the same action on the next car; thus the valves move serially and rapidly to emergency position throughout the train.

As the emergency piston continues to move to emergency position, port *H* is drawn out of register with port *v3*, but this latter port is now uncovered by the end of the slide valve so that quick-action-chamber air remains connected to the vent-valve piston to keep the vent valve open.

The emergency-reservoir air in passage *e3* is now connected through cavity *K* and passage *c6* to passage *c3*, which connects to passage *c5* in the service slide valve. As the service slide valve is also in service position and as the graduating valve has port *c5* uncovered, the auxiliary reservoir air and the emergency-reservoir air combine in passage *c3* and flows through passage *c2* and past the unseated inshot valve *126* to passage *c* and to the brake cylinder. When a brake-cylinder pressure of 15 pounds, which is developed in about one-half second, is built up on the inshot piston, the force of the inshot-piston spring is overcome and as atmospheric pressure is present on the spring side of the piston and in the inshot piston volume the piston moves to the left and spring *125* closes the inshot valve *126*.

EMERGENCY POSITION (SECOND STAGE—DELAYED BUILD-UP)

79. After the inshot valve closes, the build-up of brake-cylinder pressure continues at a slower rate from the auxiliary and emergency reservoirs through the delay choke *127*, Plate 7. The capacity of this choke is such as to allow a gradual build-up of brake-cylinder pressure from 15 pounds to 47 pounds in about 7 seconds, when the timing valve *161* unseats.

The unseating of this valve begins the third or final stage in the development of emergency-brake-cylinder pressure.

EMERGENCY POSITION (THIRD STAGE—FINAL BUILD-UP)

80. The air in the quick-action chamber is present on the left of the timing valve *161* and this air is being vented through the choke *109*, Plate 8, in the vent-valve piston. When the pressure in the quick-action chamber has reduced to a certain value

with respect to brake-cylinder pressure on the right side of the timing valve, the valve will unseat. The air from the auxiliary reservoir and the emergency reservoir will now pass through choke *153* in addition to choke *127*, thereby causing the pressure in the brake cylinder to build up at a faster rate. After the timing valve opens, the final equalization, or a pressure of 60 pounds, is obtained in one and one-half seconds.

Thus, the three-stage development of emergency-brake-cylinder pressure provides an initial development of brake-cylinder pressure to 15 pounds in one-half second, followed by a delayed build up to 47 pounds in 7 seconds and a final equalization to 60 pounds in one and one-half additional seconds. In other words, the maximum brake-cylinder pressure is obtained in approximately 9 seconds after the valve moves to emergency position.

The emergency-reservoir air, which is also brake-cylinder air, in passage *e3* flows through cavity *K* in the emergency slide valve to passage *h2* and thence to the back of the accelerated-release piston *144*. Quick-action chamber air on the right of this piston is being gradually depleted through the choke *109*, therefore the emergency-reservoir pressure on the left of the piston moves it to the right.

81. The rate of the discharge of quick-action-chamber air through the choke *109*, Plate 8, is such that the vent valve will remain open about 60 or 70 seconds, when the spring *112* will reseat the vent valve. The reason for keeping the vent valve open for a definite time is to insure the transmission of quick action, to prevent the release of an emergency-brake application before the train is at rest, thereby avoiding possible damage to it, and to insure closure of the exhaust so that the brake-pipe pressure can be restored.

82. Reason for Three-Stage Development.—The reason for a three-stage development of brake-cylinder pressure during an emergency application requires first an examination of the causes of shocks in long trains during either desired or undesired quick action. In brief the shocks are due to a difference in speed between the various parts of the train during the early stages

of an emergency-brake application. If the rate of transmission of emergency action is slow so that considerable time elapses between the initiation of the emergency action on the front and the rear of a long train, a high cylinder pressure and retarding force will develop at the front of the train before the brakes have been started to take hold at the rear.

The result is a difference in speed between the front and the rear, which results in a rapid run-in of slack and consequent shock. The more rapidly the retarding force has developed on the front and the greater the lag in the development of a corresponding retarding force on the rear, the greater will be the reduction in speed on the front and the greater the shock. Hence, the longer the train the greater will be the delay in the application of the brakes at the rear and the greater will be the weight of those sections of the train which run into one another when the slack bunches solid. Thus, shocks that may be tolerable on short trains rapidly become more severe until they become intolerable on long trains. To reduce such shocks to a tolerable limit, two things may be done. The propagation rate may be increased to obtain as nearly a simultaneous application on all cars as possible, or the rate of the development of brake-cylinder pressure may be decreased so that a lower retarding force is obtained on the front of the train until the slack has bunched and the brakes have started to apply at the rear.

83. It is impossible, owing to the friction the air encounters in flowing through the brake pipe, to increase the propagation rate to a point at which a simultaneous application of all brakes will be obtained; hence, with the "AB" brake, the rate of development of brake-cylinder pressure in emergency was modified to include three stages. The first stage comprises an initial inshot of pressure from the combined emergency and auxiliary reservoirs to the brake cylinder of a limited amount, but at an unrestricted rate; second, there is a delayed build-up of pressure; third, there is finally a fast rate of equalization. The initial rapid but limited inshot of the first stage of emergency insures a prompt movement of the brake shoe against the wheels to create a moderate retarding force on the front of the train during the time

required to transmit the quick action throughout the train. The slow build-up which follows in the second stage allows an easy closure of the slack and is timed to prevail until the slack is sufficiently bunched to permit the third stage or the rapid development of the cylinder pressure to its final high value without creating an intolerable shock.

The development of a controlled brake-cylinder pressure, as just described, is modified when a partial service-brake application precedes an emergency application and is completely annulled when the service-brake application has developed a brake-cylinder pressure of 30 pounds or more before the emergency application is made. The reason is that the higher the brake-cylinder pressure in the inshot-piston volume, the longer will be the delay in the closing of the inshot valve.

84. **Emergency After Service Applications.**—Regardless of the extent to which the brakes may have been applied in service, emergency quick action will be started and quickly relayed throughout the train whenever an emergency rate of brake-pipe reduction is produced. A brake-cylinder pressure of 60 pounds will be developed.

RELEASE AFTER AN EMERGENCY APPLICATION

85. **Explanation.**—As the brake-pipe pressure is restored to release the brakes after an emergency application, the emergency piston will begin to move to the left until the emergency piston-spring guide *130*, Plate 9, comes in contact with the stem *148* of the accelerated release piston, when the movement will be arrested. The emergency slide valve now blanks port *e3*, and cuts off the emergency reservoir from the brake cylinder. As soon as a pressure of between 20 and 24 pounds is built up on the face of the piston, the springs *150* and *151* will begin to be compressed and the piston and the slide valve will begin moving toward release position. The feed port is now open and the quick-action chamber will begin to recharge from the brake pipe. Port *h* in the slide valve will finally come into register with port *h2*, and permit the emergency reservoir air trapped at the left of the accelerated release piston *144* to pass to the

empty quick-action chamber, thereby putting the piston *144* in balance. The brake-pipe pressure on the face of the emergency piston now moves it and the slide valve as well as the accelerated-release piston to accelerated-release position, thereby compressing the emergency-piston-return spring *137*. With the emergency slide valve in release position, the air in the brake cylinder is connected through a cavity *K* in the emergency slide valve to the inshot-piston volume, thereby equalizing the air pressures on the inshot piston and causing the inshot-piston spring to open the inshot valve. The parts of the service portion are still in fully applied position because the action just described occurs at a brake-pipe pressure far below the pressure required for the complete release of the brakes by a movement of the service portion to release position.

86. Accelerated Emergency Release.—With the emergency piston and slide valve in accelerated-release position, Plate 10, the brake cylinder is connected through passage *c*, the inshot valve *126*, passages *c2*, *c3*, *c6*, cavity *K* in the emergency slide valve, and passage *c9* to the under side of ball check-valves *94* and rubber-seated check *93*. The auxiliary reservoir and the brake cylinder are connected through port *c5* in the service slide valve, which is still in service position to passage *c3*, and as the pressure in these volumes exceeds the pressure in the brake pipe, the valves *94* and *93* will be unseated and permit the air from the auxiliary reservoir and the brake cylinder to pass through passage *b4* to the brake pipe. This provides a quick serial initial build-up of brake-pipe pressure to about 47 pounds when the accelerated-release check is closed by its spring.

The quick-action chamber is being charged through the charging choke *138* and as soon as the pressures on each side of the emergency piston become about equal, the return spring *137* will move the emergency piston and slide valve from accelerated-release to charging position. The emergency slide valve now blanks port *c9* and breaks the connection between the brake cylinder and the brake pipe. The timing valve will be forced to its seat by the air in the quick-action chamber when the brake cylinder is connected to the exhaust by the service portion.

The service piston and its slide valve will move to either full recharge or to retarded recharge position when the brake-pipe pressure exceeds slightly the pressure in the auxiliary reservoir. All of the reservoirs will then be recharged as already described when considering Release After a Service Application.

87. The reason for preventing the feed-back function from operating until the brake-pipe pressure has increased to about 22 pounds is to cause the auxiliary and the emergency reservoir pressures to equalize at a pressure of about 57 pounds or a higher brake-pipe pressure than is required to release a "K" triple valve. The reason for this is to prevent these reservoirs from absorbing air from the brake-pipe until the "K" triple valves have all released, thus insuring a positive release of all of these valves in a mixed train. Under the varying conditions of piston travel, it is generally assumed that a brake-pipe pressure of about 55 pounds will cause a "K" triple valve to move to release position after an emergency application.

If the combined auxiliary reservoir and brake-cylinder pressures are 60 pounds at the start of the release, after an emergency application, the brake-pipe pressure during the feed-back action will rise from about 22 pounds to 43 pounds, and the auxiliary reservoir and the brake-cylinder pressures will fall at the same time to 52 pounds before the accelerated-release checks will close. These values are based on the assumption that the spring above these checks has a tension of 10 pounds. After the pressure in the brake pipe has increased from 43 to slightly over 52 pounds, the service portion will move to release position, after which the air in the emergency reservoir which has been held at 60 pounds will equalize with the air in the auxiliary reservoir at about 57 pounds. Thus, up to a pressure of 57 pounds, no air will be absorbed by the reservoirs of the "AB" equipment from the brake pipe. These are test rack pressures for a single car and will vary with length of train.

88. The reason for the use of the 10-pound spring over the accelerated-release check *93*, Plate 10, is to prevent the auxiliary reservoir and the brake-cylinder pressures from reducing to too low a value during the feed-back. For example, if a

weaker spring were used and these pressures were permitted to decrease to much less than 52 pounds, the pressure of equalization of the emergency reservoir and the auxiliary reservoir would be less than 57 pounds, or near the average pressure required to obtain a release of the "K" valves.

DUPLEX RELEASE VALVE

89. The purpose of the duplex release valve is to provide a means of draining the air from the auxiliary reservoir alone or from both the auxiliary and the emergency reservoir at the same time. The release-valve handle, Plate 1, may be moved in any direction to open the release checks *69* and *69a*. The plunger *70* has two stems, which are lifted to unseat the release checks when the handle *72* is moved. There is less clearance between the auxiliary release check *69* and its plunger stem than between the emergency-reservoir release check *69a* and its stem. Therefore, if the handle is moved part way the auxiliary release check is lifted from its seat and the reservoir is drained without opening the emergency-reservoir release check. If the handle is moved its full travel, both release checks are unseated and both reservoirs drained.

GENERAL INSTRUCTIONS

90. **Releasing a Brake.**—To release an individual brake by means of the release valve, with the brake pipe charged, pull the handle of the duplex release valve only far enough to open the auxiliary-reservoir check but not far enough to open the emergency-reservoir check, and then permit the auxiliary-reservoir air to discharge until the brake-cylinder exhaust is heard to start.

To release a brake when there is no air in the brake pipe, drain both the auxiliary and the emergency reservoirs by pulling the handle of the duplex release valve its full travel, and then holding both check-valves open until all pressure is drained.

91. **Cutting Out a Brake.**—To cut out a brake, close the cut-out cock in the branch pipe and then drain both reservoirs by pulling the handle of the duplex release valve its full travel.

92. **Time Required To Charge Brake System.**—Because of the use of an emergency reservoir in addition to the auxiliary reservoir, approximately twice as long is required to charge the brake system as with the "K" equipment. This condition should be taken into account, especially when picking up a car on the road, because the brake may fail to apply during the road test of brakes unless sufficient time is allowed for charging.

93. **Blow at Main Exhaust Port.**—After an emergency-brake application, the vent valve remains open for a definite period and there is a slight exhaust at the main exhaust port of the emergency portion for at least 1 minute. The brake should not be considered defective because of a leak at this exhaust port unless the blow continues longer than 2 minutes.

MAINTENANCE OF AIR-BRAKE EQUIPMENT ON CARS

Adopted as Standard 1925

Revised 1933 and 1934

These rules were formulated jointly by the Bureau of Safety of the Interstate Commerce Commission and the Safety Appliance Committee, of the Mechanical Division of the American Railway Association. They represent minimum requirements, and shall govern the maintenance of air-brake and air-signal equipment on cars, provided that nothing herein contained shall be construed as prohibiting carriers from enforcing additional rules and instructions not inconsistent with these rules.

FREIGHT AND PASSENGER TRAIN—CAR BRAKES MAINTENANCE OF

Brakes on Cars on Shop or Repair Track With Stencils "In Date"—Tests and Repairs

100. When freight cars are on shop or repair tracks where facilities are available for making air-brake repairs, and the stencil date is twelve months old or over (except for complete AB-type freight brake equipment using the AB-type brake cylinder, where the stencil date is thirty-three months old or over), the brake equipment should be given the attention specfied for cars requiring periodical repairs.

101. Cars on shop and repair tracks with stencil dates less than limits specified in Rule 100, should be connected to an air plant equipped

with testing apparatus and a dummy coupling attached to hose on the opposite end of car. The pipe, including angle cocks, cut-out cock and hose, should be tested under a pressure of not less than 70 pounds, using soap-suds for this test when weather conditions permit. All leakage should be reduced to a minimum. Any hose found porous or leaking around the fittings, or otherwise defective, and any cocks found leaking at top of key should be removed. Brake pipe must be securely clamped, angle cocks in their proper position with suitable clearance, reservoirs and cylinders tight on their supports and the latter securely attached to car, and piston travel adjusted to from 7 in. to 9 in.

102. The brake cylinder must be tested for leakage with a gage attached to the retaining-valve exhaust or triple-valve exhaust port, and the triple valve tested with a specified testing device to determine whether it will apply and release properly in both service and emergency applications. If the triple valve fails to pass this test or the brake-cylinder leakage exceeds 8 pounds per minute, the entire brake equipment must be given the attention specified for cars requiring periodical repairs when stencil is out of date. If triple valve and brake cylinder pass the prescribed test, the retaining valve and its pipe connections must be tested by applying the brake with a 20 pounds reduction from not less than 70 pounds brake-pipe pressure and when the triple valve is released the retaining valve must hold the brake applied for a period of not less than three minutes.

103. The hand brake and connections must be inspected, tested and necessary repairs made to insure that it is in suitable condition for safe and effective operation when the car is in motion.

Air Brakes on Cars—Periodic Repairs

110. The air-brake equipment on cars must receive the inspection and repairs prescribed in Rules 112 to 169, inclusive, as often as required to maintain it in suitable condition for service, but not less frequently than once in fifteen months (except for complete AB-type freight brake equipment using the AB-type brake cylinder, on which the time limit is thirty-six months).

"AB" Freight Brake Equipment—Cleaning, Lubricating and Testing

200. The cleaning, lubricating, and testing of the AB-Brake equipment shall be in accordance with the Interchange Rules.

201. The service and emergency portions must be removed from the car for cleaning and lubricating and replaced by one in good condition. They must be dismantled and all internal parts cleaned with gasoline or a turpentine substitute, preferably the former, then blown off with compressed air and wiped dry with a cloth. Before assembling the parts

TOOLS FOR "AB" VALVE SERVICE AND EMERGENCY PORTIONS

Name	Purpose	Length	Principle Dimensions
Double end, hex.	5/8" nut and 5/8" cap screw.	9 5/8"	1 1/32" and 29/32" openings.
Double end, hex.	1/2" cap screw and strainer nut wrench.	7 3/8"	25/32" and 11/16" opening.
Double end, hex.	3/8" cap 1/4" brass pipe, plug and 1/4" iron plug.	6 5/8"	19/32" and 3/8" openings.
Plug driver.	1/4" choke plug.	9 1/4"	3/32"×7/16" bit.
Screw driver.	1/8" choke plug.	9"	1/16"×5/16" bit.
Tee socket.	5/8" cap screw.	9"	29/32" hex.
Strainer nut wrench.	....	1 13/32"	2 1/2" diameter, bit 1/4"×1/4", 11/16" square on back.
Pin spanner.	Piston tail spring cap nut.	10"	1 3/16" diameter, 1/4" pins.
Square box.		12"	1 1/32" square, 1/8" fillets.
Hex. box.	Release insuring cap nut.	12"	1 7/32" hex.
Pin face.	Vent valve piston wrench.	13"	1 1/2" between 3/16" pin; 1 1/8" offset.
Tee socket.	3/8" cap screw.	6"	19/32" hex.
Tee socket.	1/2" cap screw.	9"	25/32" hex.
Offset socket.	5/8" nut.	10"	1 1/32" hex., 2 1/4" offset.
Blank plug.	Emerg. Por. Ring Test.	1 3/8"	1/8" Pipe thd.
Adjusting Wrenches	Release Insuring Valve Adjustment.	....	....

after cleaning, the castings and parts in the valve body must be thoroughly blown out with compressed air and all parts of the valve not elsewhere provided for known to be in good condition. All service and emergency portions after being cleaned or repaired must be tested on an approved test rack.

"AB" Equipment—Service Portion

202. The hair strainer must be removed, inspected and be thoroughly blown out with compressed air. Any dirt must be shaken or scraped from the exterior of the strainer. Cleaning fluids must not be used because they destroy the oil coating of the hair, which coating is essential to proper operation of the strainer. If the strainer indicates disintegration of the hair, it should be replaced. Additional oil must not be applied to the strainer.

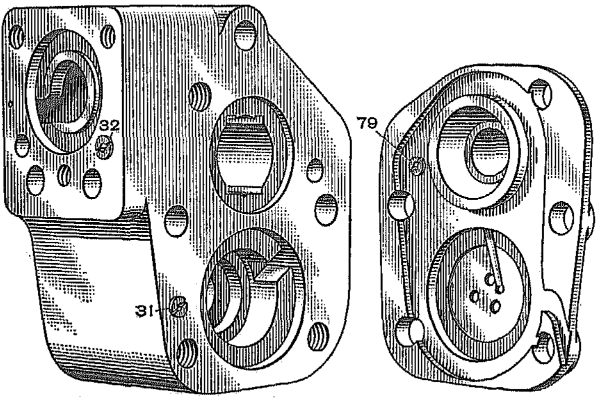


Fig. 13

203. The valve portions should be properly protected from exposure to dirt and damage while being transported to and from the shop.

204. In dismantling the portions, care must be exercised to avoid distortion of bolts, studs, nuts, etc., which can best be done by using the type of wrenches described under heading "Tools for AB Valve." Care must be taken to avoid damage to parts when dismantling or assembling the valves, particularly pistons, springs, gaskets, slide valves, graduating valves, etc. If excessive force is required in removing or applying any part of the valve structure, investigation should be made to ascertain the cause, otherwise, serious damage to parts may result, particularly in removing the emergency piston or vent-valve piston, see paragraph 225.

205. The service portion contains three choke fittings which govern the flow of air through the ports in which they are located. The size of these chokes is important and whenever a service portion is dismantled

the chokes should be cleaned and inspected to insure that they are not restricted. It is preferable to remove these chokes one at a time for inspection and cleaning. As each choke is finished it should be replaced before the next choke is removed so as to insure against the possibility of getting the chokes replaced in wrong locations. The chokes can be cleaned in gasoline or other approved cleaning fluid and then blown off with a jet of compressed air. Metallic tools must not be used for cleaning chokes.

206. The three chokes located in the service portion are indicated by numbers, Fig. 13, and are as follows:

207. Choke 31, which is located in the body under the release-insuring-valve cover. This choke controls the flow of air during preliminary quick service from the quick-service-reservoir volume to atmosphere.

208. Choke 32 is located under the limiting-valve cover. This choke controls the flow of air in the quick-service passage between the slide valve and the limiting valve during secondary quick service.

209. Choke 79 is located in the release-insuring-valve cover. This choke controls the flow in the passage between the release-insuring valve and the slide valve exhaust in service and in service lap positions.

210. The correct sizes for the orifice of these chokes are as follows:

31 $\frac{1}{32}$" drill
32 $\frac{1}{32}$" drill
79 $\frac{1}{32}$" drill

211. The service portion should be completely dismantled and all parts inspected and cleaned. When cleaning, the parts (excepting the body) should be washed in gasoline or any other suitable fluid which will dissolve any oil or grease and permit all parts to be thoroughly cleaned without abrasion.

212. All gaskets or rubber-seated valves in this portion may be dipped in gasoline to assist in the removal of greasy dirt, but these parts must be promptly wiped dry after cleaning and must not be allowed to soak in gasoline, or other cleaning fluid.

213. Defective gaskets and diaphragms must be replaced with standard gaskets and diaphragms as furnished by the air-brake manufacturers.

214. When the service portion is dismantled for general cleaning, all springs should be inspected after cleaning. Springs which show rust pits, or are otherwise defective should be replaced by springs known to be correct.

215. The following tabulation gives the data necessary to identify each of the springs used in the service portions:

(35) Graduating-Valve Spring, which holds the graduating valve to its seat.

(37) Slide-Valve Spring, which holds the service slide valve to its seat.

(39) Piston Spring, which is mounted in the piston stem and resists movement of piston and graduating valve after the feed grooves are closed and just previous to opening of the preliminary quick-service port.

(43) Return Spring, which returns the piston and slide valve to normal recharge position.

(49) By-Pass Check-Valve Springs, which serve to hold the by-pass check-valves to their seats with a small differential so that either check can open and by-pass the strainer when dirt restricts the strainer. One check operates during application and the other during release of the brake.

(57) Check-Valve Spring, which serves to hold the limiting-valve check and the back-flow check to their seats.

(63) Diaphragm Spring, which acts on the diaphragm of the quick-service limiting valve to hold this valve open until the force of the spring is balanced by a brake-cylinder pressure of ten pounds.

(71) Duplex Release Valve Plunger Spring, which returns the plunger to normal position when the operating rod is released, so that the reservoir release check-valves can return to their seats.

(73) Check-Valve Springs, which serve to hold the auxiliary and emergency reservoir release check-valves to their seats when the release-valve plunger is down.

(76) Release-Insuring-Valve Spring, which holds this valve on its seat until brake-pipe pressure rises 1½ pounds above auxiliary-reservoir pressure.

"AB" SERVICE PORTION SPRING IDENTIFICATION TABLE

Ref. No.	Approx. Free Height	Outside Diameter	Diameter of Wire	Remarks
37		(Flat type spring)		Slide valve spring.
35	21/32	.161	.0201	Graduating valve spring.
43	3 45/64	1.844	.1562	Return spring.
39	2 21/64	.791	.072	Piston spring
76	1 7/32	.485	.0475	Release-insuring-valve spring.
49	1 11/32	.807	.0571	By-pass check-valve spring.
57	53/64	.473	.0359	Check-valve spring.
63	2 33/64	1.144	.128	Diaphragm spring.
71	2 15/16	.928	.0985	Reservoir release valve plug and spring.
73	1 15/32	.557	.0571	Check-valve spring.

Lubrication

220. The face of the graduating valve, the upper surface of the slide valve which is the graduating-valve seat, the slide-valve seat and the upper portion of the bushing where the slide-valve spring bears must be lubricated with the best grade of very fine pure dry Air Brake graphite.

221. To apply the graphite lubricant it will be found convenient to use a small wooden paddle about 8 inches long, having a small piece of chamois skin glued to the paddle end. The width of this paddle must be somewhat less than the width of the slide-valve seat in the bushing. Place a small quantity of the graphite on the chamois skin and rub the surfaces specified until they show a dark copper color. There must be no free graphite allowed to remain on the valves or seats and they must be free from any oil or grease.

222. Before the cleaned piston is replaced in the piston bushing, three drops of approved triple-valve oil must be placed in the groove and the ring must be moved around to distribute the oil. Insert the piston and slide valve in the body, leaving them in release position, then lubricate the piston cylinder sparingly and move the piston back and forth several times, after which remove the surplus oil from the outer edge of the cylinder.

Emergency Portion

225. When the emergency portion is dismantled for cleaning, the main piston must not be removed without first removing the upper cover and taking out the diaphragm strut which serves to hold the emergency slide valve to its seat. Damage will result if force is used to remove the emergency piston from its bushing without first removing the diaphragm strut.

226. The springs behind the emergency vent valve and the inshot valve are held in place by circular sheet-metal retainers which have lugs on two opposite sides. These lugs engage under a lip around the outer end of the cavities in the body casting. To remove the spring and valve, press down on the spring retainer and tilt it so that one lug is exposed upwards. When in this position the parts can be readily removed and they can be reassembled by using the same method.

227. The individual emergency portion parts such as piston, rings, bushings, valves, springs, and gaskets must be cleaned and inspected in the same manner as specified for similar parts of the service portion.

228. The emergency portion contains seven choke fittings which govern the flow of air through the ports in which they are located. The instructions for cleaning and checking choke fittings in the service portion applies for all of these chokes except three; No. 109, No. 97-A and No. 95-A, which are not readily removable and should be cleaned

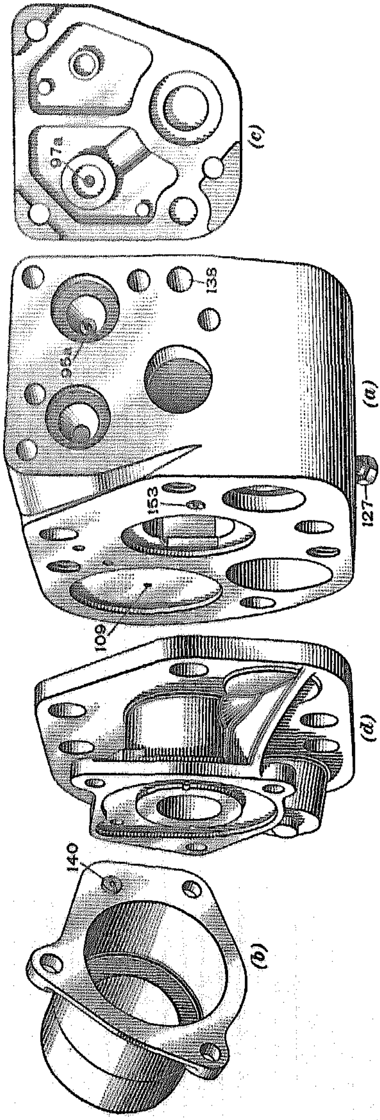


Fig. 14

in place. They are indicated by reference numbers in Fig. 14, and are as follows:

229. Choke 127. This choke is located in the emergency-portion body and is accessible by removing a brass pipe plug. This choke controls the second-stage flow of air to the brake cylinder immediately after the inshot valve closes during an emergency application.

230. Choke 153. This choke is under the emergency-portion cover and is located in the port which by-passes choke 127 when the timing valve opens. It controls the third stage of brake-cylinder rate of pressure rise during an emergency application.

231. Choke 138. This choke is under the top cover of the emergency portion and is located in the charging port. It controls the quick-action chamber charging rate.

232. Choke 109. This choke is located in the large vent-valve piston and serves to control the rate quick-action-chamber pressure reduces during emergency application. The orifice size for this choke is No. 69 drill.

233. Choke 140. This choke is placed at the flange of the accelerated-release cylinder and is located in the port which leads from the emergency slide-valve seat to the chamber back of the accelerated-release piston. This choke serves to protect against excessive leakage past the accelerated-release piston and its seal.

234. Choke 95-A. This choke is located in the bushing under the spillover ball check-valve 95. The choke serves to protect against excessive check-valve leakage, the orifice size in this choke being $\frac{3}{64}$" drill.

235. Choke 97-A. This choke is located in the cover above the spillover check-valve 95, which serves to protect against diaphragm leakage and is located in the port leading to chamber above the diaphragm strut. The orifice size for this choke is $\frac{1}{32}$" drill.

236. The correct sizes for the orifice of the above chokes are as follows:

127	$\frac{3}{32}$" drill
153	$\frac{9}{64}$" drill
138	No. 73 drill
109	No. 69 drill
140	$\frac{1}{32}$" drill
95-A	$\frac{3}{64}$" drill
97-A	$\frac{1}{32}$" drill

237. The emergency portion has a total of 11 springs, which are designated as follows:

(96) Accelerated Emergency Release Check-Valve Spring, that serves to hold the check valve 93 to its seat.

(98) Spillover Check-Valve Spring, which serves to hold the check valve 97 to its seat.

(101) Diaphragm Spring, which serves to hold the emergency slide valve to its seat when the diaphragm is balanced.

(112) Vent-Valve Spring, which holds the emergency vent valve to its seat.

(124) Inshot Piston Spring, which resists the inshot-piston movement until the brake-cylinder pressure rises to 15 pounds.

(125) Inshot Check-Valve Spring, which holds the check-valve in contact with the inshot-piston stem.

(131) Emergency-Piston Spring, which resists the movement of the spring guide in the emergency-piston stem.

(134) Graduating-Valve Spring, which serves to hold the graduating-valve to its seat on the slide valve.

(137) Return Spring, which returns the piston and slide valve to normal release position when the brake pipe and quick-action-chamber pressures are equalized.

(150) Accelerated Emergency Release Piston Inner Spring, which serves to resist movement of the emergency piston to accelerated release position at the beginning of a release after an emergency application.

(151) Accelerated Emergency Release Piston Outer Spring, which serves the same purpose as spring 150.

238. The following tabulation gives the data necessary to identify each of the springs described:

"AB" EMERGENCY PORTION SPRING IDENTIFICATION TABLE

Ref. No.	Approx. Free Height	Outside Diameter	Diameter of Wire	Remarks
96	$1\frac{13}{32}$	.744	.072	Emergency-release check spring.
98	$1\frac{3}{32}$	.479	.0285	Spillover check-valve spring.
101	$1\frac{1}{8}$	,689	.0641	Diaphragm spring.
112	$2\frac{23}{32}$	$1\frac{3}{8}$	.125	Vent-valve spring.
124	$2\frac{41}{64}$	1.192	.0985	Inshot-piston spring.
125	$1\frac{23}{32}$	.522	.0508	Inshot-check-valve spring.
131	$2\frac{41}{64}$	.791	.072	Emergency-piston spring.
134	$\frac{31}{32}$	.161	.0201	Graduating-valve spring.
137	$3\frac{43}{64}$	1.184	.1562	Return spring.
150	$2\frac{3}{4}$	1.204	.1416	Holding-piston inner spring.
151	$3\frac{7}{32}$	1.941	.207	Holding-piston outer spring.

Lubrication

240. The piston, slide valve and graduating valve of the emergency portion must be lubricated as specified for similar parts of the service portions. The emergency vent-valve piston and the accelerated-release piston must be lubricated in the same manner as the main piston. When the portions are being assembled the diaphragms must be carefully inspected to insure that the diaphragm surfaces are dry and free from any oil or grease.

"AB" Brake Cylinder

245. To clean and lubricate, the cylinder must be dismantled by removing the non-pressure head and piston assembly of the cylinder.

246. The brake cylinder does not have a follower bolted to the piston. The cylinder packing covers the entire piston head and is arranged so that it snaps on the piston and is held in place by a bead on the piston which fits into the non-pressure side of the packing.

247. When the cylinder is dismantled the packing must be removed, cleaned, and inspected. If there are any cracks or deep scratches on the packing bearing surface or if the packing is worn too much to hold a proper bearing on the cylinder wall, it should be replaced.

248. Before a cleaned or new packing is applied, the felt swab on the piston must be carefully cleaned, relubricated, and adjusted so that it will contact all around when the piston is replaced in the cylinder. The cylinder must also be cleaned so as to remove all dirt and old lubricant and the walls relubricated with a suitable brake-cylinder lubricant.

249. While the cylinder is dismantled the release spring must be inspected and cleaned so as to remove any rust or dirt which might be clinging to it and later find its way to the cylinder walls. If the spring has shown any rust spots it should be covered with a rust preventive after cleaning.

250. The hair strainer and the piston-rod seal in the non-pressure head must be removed and thoroughly cleaned. This strainer can be removed for inspection from the inside of the head. It is held in place by a wire spring. By closing the ends of the spring the strainer parts are released for removal.

251. If the hair in the strainer is broken or deteriorated so that it cannot be put in good condition by blowing out, it should be renewed.

252. The piston rod should be cleaned and all rust or rust spots removed and if the piston-rod seal rings show excessive wear or any other defects which would interfere with the sealing function, they should be renewed.

253. When assembling the dismantled brake cylinder, special care must be taken to insure that no dirt or other foreign substance enters the cylinder before it is closed.

TYPE K FREIGHT-CAR BRAKE EQUIPMENT

Serial 3233 Edition 1

DESCRIPTION AND OPERATION

INTRODUCTION

1. The air-brake equipments for freight cars which were used prior to the type K equipment were known as the H C and H D freight-car brake equipments. The only difference between the H C and H D equipments was that the auxiliary reservoir and the brake cylinder were combined in the first instance, whereas these parts were detached in the latter in order to permit their application to certain types of cars. The brake cylinder was known as the type C with the combined equipment and as the type D with the detached equipment. The same kind of triple valve or the type H was used in both cases, and the equipments were designated by combining the letters H C and H D.

DISADVANTAGES OF H C EQUIPMENT

2. **Effect of Long Trains.**—Longer freight trains and heavier cars introduced problems in the control of these trains which could not be met successfully by the type H triple valve used with the H C and H D freight-brake equipments. The H triple valve was designed for trains with a maximum length of about fifty cars, and it was found that, with trains of much greater length, too great an interval elapsed between the application of the front and the rear brakes when applied in service

as well as between the release of the brakes and the recharging of the auxiliaries at the front and the rear ends of the train.

3. How Brakes Should Operate.—In order to control a train safely and with the least damage to equipment and lading, the brakes should apply and release and the auxiliary reservoirs should recharge simultaneously or as near the same time as possible. If the brakes do not operate in this manner, the action is as follows: When the brakes apply on the front part of the train at a considerable interval before they apply near the rear, the speed of the cars on the front end will be retarded while for a time the speed of the cars at the rear will not change. As considerable slack exists in a long train, the rear cars close up to the front cars or, as usually stated, the slack runs in. The result is a shock, the severity of which will depend on the difference in the velocity between the two parts of the train, the weight of the cars, and the time required for the velocities to equalize. When the brakes finally begin to apply on the rear cars, the slack, assisted by the draft-gear springs, runs out, and may cause the train to break in two.

When the brakes release on the front part of the train first, and the train is in motion with the slack not all out, the front part of the train will pull away from the rear part, and the result will be a severe shock or a break-in-two.

When the brake pipe and the auxiliary reservoirs recharge faster on the front end of the train, the pressure banks up in this part of the train, and when the brake valve is placed in running position, the air begins to move to the rear of the train where the pressure is lower. The fall in pressure on the front part of the train due to the movement of the air, is equivalent to a brake-pipe reduction, and some of the head brakes are liable to apply lightly or creep on, and may cause the wheels to slide.

4. Why Front-End Brakes Apply First.—The reason why, with the H triple valves, the brakes on the front end of the train apply considerably in advance of the brakes on the rear is as follows: The discharge of the air from the brake pipe when applying the brakes in service occurs at the front end of the brake pipe at the brake valve. The rate at which the air discharges is

dependent on the opening at the exhaust port in the brake valve and on the friction the air encounters in passing through the pipe. The size of the opening at the brake valve remains the same, and the volume and friction of the air increases with the length of the pipe, therefore more time is required to discharge the air as the length of the brake pipe is increased. The air cannot pass from the auxiliary reservoirs to the brake cylinders any faster than the air discharges from the brake pipe, and therefore the delay in the application of the brakes toward the rear of the train increases with its length. The effect is to set up undesirable stresses in the train as already described. The rate of reduction on the rear part of the train may be so slow that sufficient difference between the pressure in the brake pipe and in the auxiliary reservoir may not be formed to move the triple valves to service position, and the air from the auxiliary reservoir will pass through the feed grooves into the brake pipe. Also, when the difference in pressures is small, the triple valve, in its movement to service position, stops as soon as the slide valve starts to open the port to the brake cylinder, because the reduction which then occurs in the pressure in the auxiliary reservoir destroys the difference of pressures which acts to move the triple piston. As a result, the air from the auxiliary reservoirs may not pass to the brake cylinders faster than the air escapes through the leakage grooves.

5. The air in the brake pipe could be exhausted more rapidly if the opening at the brake valve were increased, but if this were done there would be a liability of quick action. Furthermore, a quicker reduction in pressure at the head end of the train would, even if quick action did not occur, cause heavy shocks by the slack running in and out at the rear.

Therefore, proper brake operation requires as nearly a simultaneous application and release of the brakes as possible, as well as a uniform recharge of the auxiliary reservoirs.

6. **Introduction of the Type K Triple Valve.**—The undesirable features of the type H triple valve as just explained, led to the introduction of a freight-brake equipment in which the type H triple valve was replaced by the type K triple valve.

This equipment is known as the type K freight-car brake equipment, and is designed to overcome the objectionable features of the brake equipment that used the H triple valve.

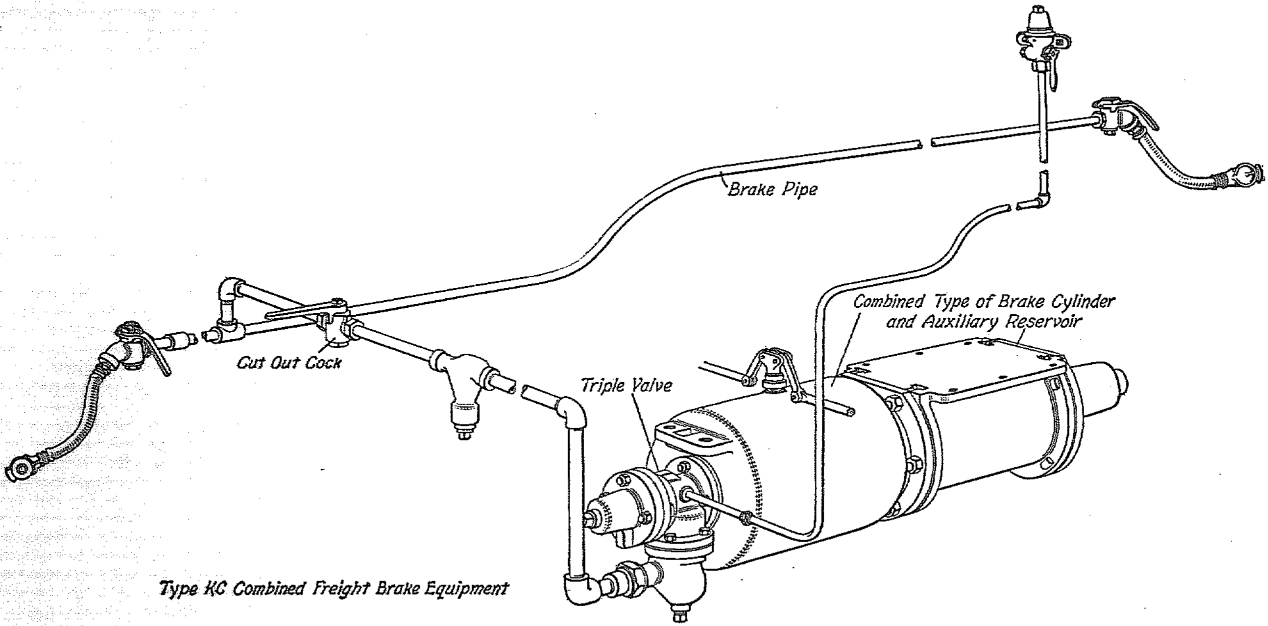
The purpose of any triple valve is to apply its brake, release the brake, and recharge the auxiliary reservoir, and it is due to these triple functions that the valve obtains its name.

The K triple valve performs the same functions as the H triple valve, and also has the following new features: (*a*) A quick-service feature, so called because, when the brakes are applied in service on a long freight train, the triple valves assist the brake valve in reducing the brake-pipe pressure, the result being a more rapid, positive, and uniform application of the brakes throughout the train; (*b*) a uniform release feature, so called because, when the brakes are being released, the triple valves discharge the air slowly from the brake cylinders on the front part of the train, and at the normal rate from the brake cylinders on the rear part of the train, thereby making possible a more uniform release of all brakes; (*c*) a uniform recharge feature, so called because, when the auxiliary reservoirs are being recharged, the triple valves restrict the passage of air to the auxiliary reservoirs on the front portion of the train where the pressure is highest and permit a normal rate of feed to the auxiliary reservoirs on the rear, thereby causing all of the reservoirs to recharge at about the same rate.

The object of the quick-service feature is therefore to bring about a more rapid service application of the brakes, and the object of the uniform release and uniform recharge features is to cause the brakes to release and the auxiliary reservoirs to recharge at about the same rate.

PIPING DIAGRAMS OF TYPE K EQUIPMENTS

7. Types of Equipment.—The type K freight-car brake equipment is classified according to the arrangement of the auxiliary reservoir and the brake cylinder. The equipment is referred to as the type K C when the auxiliary reservoir and the brake cylinder are combined as shown in the piping diagram in Fig. 1, because a type K triple valve and a type C brake cylinder are used. The detached equipment is shown in Fig. 2, and



Type KC Combined Freight Brake Equipment

FIG. 1

is known as the type K D because a type K triple valve and a type D brake cylinder are used. This type of brake cylinder is always separate from the auxiliary reservoir.

8. **Description of Arrangement.**—The equipment for one freight car as shown in Fig. 1 consists of a 1¼-inch brake pipe with a 1⅜-inch hose at each end, a 1¼-inch branch pipe that connects the brake pipe to a 1-inch pipe at the triple valve, a type K triple valve, an auxiliary reservoir with a release valve, a brake cylinder, and a pressure retaining valve connected by a ⅜-inch pipe to the exhaust port of the triple valve. A cut-out cock and

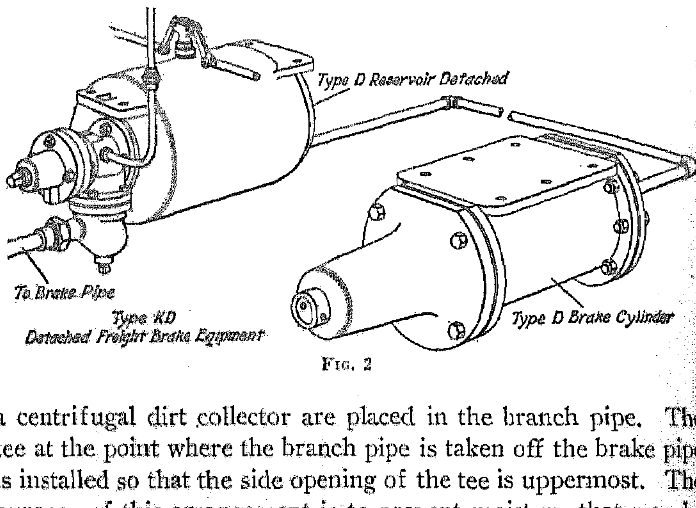


FIG. 2

a centrifugal dirt collector are placed in the branch pipe. The tee at the point where the branch pipe is taken off the brake pipe is installed so that the side opening of the tee is uppermost. The purpose of this arrangement is to prevent moisture that may be deposited in the brake pipe from draining into the branch pipe and triple valve. Wherever practicable, the triple valve should be placed above the general level of the piping, and the piping should be so arranged as to avoid pockets where moisture may collect.

The arrangement shown in Fig. 2 comprises the same parts with the exception of the 1-inch pipe, used to connect the auxiliary reservoir to the brake cylinder.

DESCRIPTION AND OPERATION OF PARTS

TYPE K TRIPLE VALVE

9. **Views of Triple Valve.**—There are two sizes of K triple valves; the K-1 valve used with brake cylinders that are 6 and 8 inches in diameter, and the K-2 that is used with a 10-inch brake cylinder.

In Fig. 3 is shown a perspective view of a K-2 triple valve, and in Fig. 4 is shown a sectional view of the valve. The K triple valve can be identified by the symbol letter and number

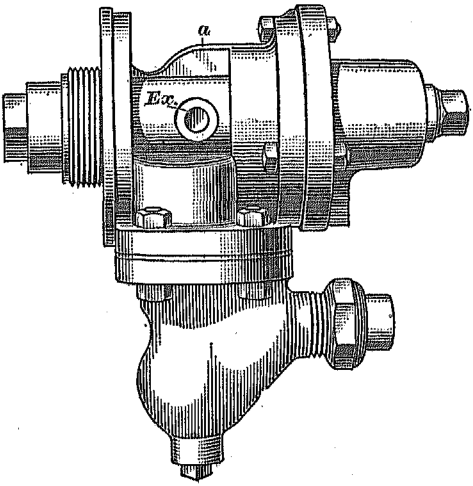


Fig. 3

K-1 or K-2 cast on the side of the valve body. The fin *a* cast on the top of the valve body also serves to identify a K triple valve. Triple valves of the H type that have been converted to K triple valves have this fin applied by a setscrew.

The K-1 triple valve is further distinguished from the K-2 by having two bolt holes in the reservoir flange where it is bolted to the auxiliary reservoir, whereas the K-2 triple valve has three holes.

The exhaust port of the triple valve is marked *Ex.*, and the pipe that leads to the retaining valve is screwed into this port.

There is a similar port on the other side so as to permit the pipe to be connected to the most convenient side. The opening not used is closed by a plug.

10. Names of Parts.—The names of the parts of a K-2 triple valve, Fig. 4, are as follows: *2*, valve body; *3*, slide valve; *4*, triple piston; *6*, slide-valve spring; *7*, graduating valve;

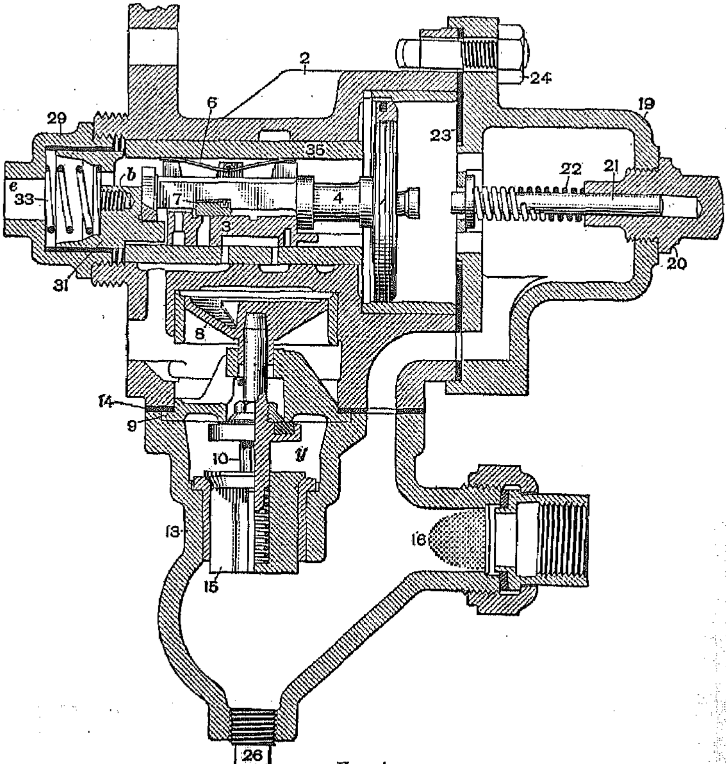


Fig. 4

8, emergency piston; *9*, emergency-valve seat; *10*, emergency valve; *13*, check-valve case; *14*, check-valve case gasket; *15*, check-valve; *16*, strainer; *19*, cylinder cap; *20*, graduating-stem nut; *21*, graduating stem; *22*, graduating spring; *23*, cylinder-cap gasket; *24*, cylinder-cap bolt and nut; *26*, drain plug; *29*, retarding-device body; *31*, retarding stem; *33*, retarding spring; *35*, slide-valve bushing.

11. **Movable Parts.**—The K triple valve contains two sets of movable parts, the service parts and the emergency parts. The latter parts operate only when an emergency application is made; the service parts operate in both service and emergency.

The service parts of the triple valve, Fig. 4, are the triple piston *4*, the slide valve *3*, and the graduating valve *7*. The emergency parts are the emergency piston *8*, the emergency valve *10*, and the check-valve *15*.

12. **Triple Piston.**—The triple piston, the graduating valve, and its spring, are shown removed from the triple valve in Fig. 5. The purpose of the triple piston is to move the graduat-

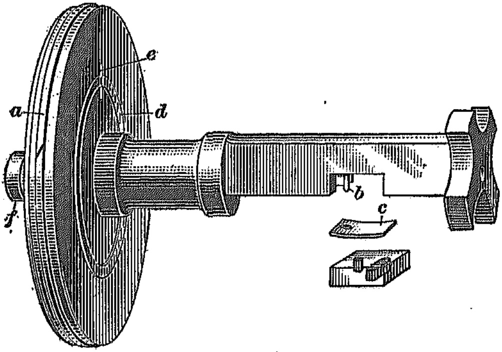


Fig. 5

ing valve and the slide valve and also to open and close the feed groove. The triple piston is moved by the difference of pressures between the auxiliary reservoir and the brake pipe, and it may be regarded as being a movable wall between these pressures. The packing ring *a* causes the piston to form as nearly as possible an air-tight joint between the pressures in all positions except release.

The graduating-valve pin *b* holds the graduating-valve spring *c* in position in the slot in the piston stem. The pin also extends into a hole in the top of the graduating valve and prevents it from being assembled in the wrong position on the stem. The purpose of the spring *c* is to hold the graduating valve on its seat in the absence of air pressure, and thereby prevent dirt from getting under the valve.

The circular ridge *d*, in a certain position of the triple valve, makes an air-tight joint with the brass bushing *35*, Fig. 4, with the exception of what air can leak through the small feed groove *e*, Fig. 5. The knob *f* is used so that the triple piston can be grasped readily when applying or removing it from its bushing.

13. Slide Valve.—In Fig. 6 (*a*) is shown a bottom view of the slide valve removed from the triple valve. The valve is shown transparent in order to bring out the relation of the ports, passages, and cavities.

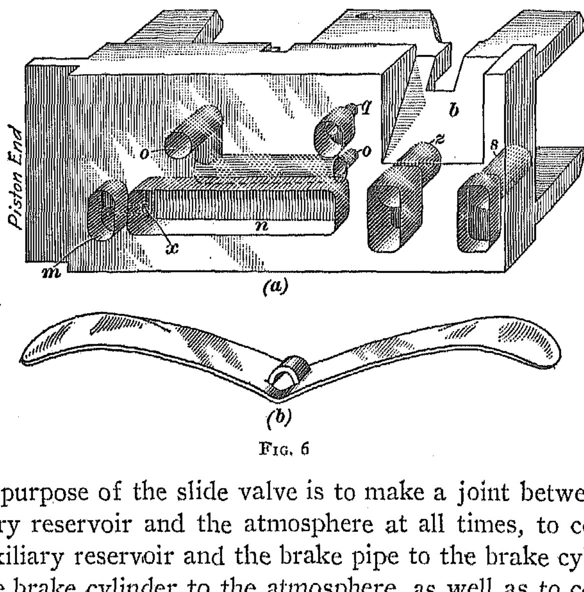


FIG. 6

The purpose of the slide valve is to make a joint between the auxiliary reservoir and the atmosphere at all times, to connect the auxiliary reservoir and the brake pipe to the brake cylinder, and the brake cylinder to the atmosphere, as well as to connect the auxiliary reservoir to the space above the emergency piston. The purpose of the various ports and passages will be explained when the operation of the triple valve is taken up.

The slide-valve spring, Fig. 6 (*b*), is pinned to the slide valve, and as the outer ends of the spring bear against the slide-valve bushing, the valve is held firmly to its seat. Dirt is thereby prevented from getting between the valve and its seat in the absence of air pressure.

The ends of the six wings on the slide valve bear lightly against the interior of the slide-valve bushing, and serve to keep the valve in the proper relation to its seat.

14. **Graduating Valve.**—The graduating valve as viewed from the face is shown in Fig. 7. The face of the valve contains a cavity *v* as shown.

The purpose of the graduating valve is to open and close the service port in the slide valve, and thereby make possible a graduated application of the brake. The cavity in the graduating valve also permits air from the brake pipe to pass through the

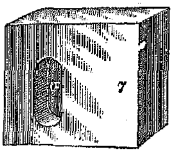


FIG. 7

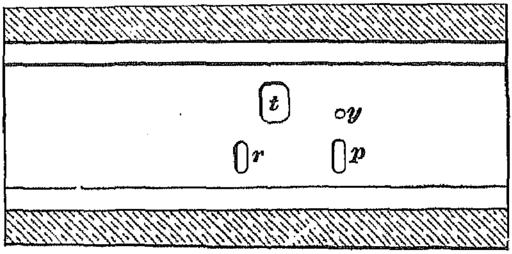


FIG. 8

slide valve to the brake cylinder in quick-service position. On this account the plug type of graduating valve as found in older triple valves cannot be used with the K triple valve, and the graduating valve therefore has to be made flat.

15. **Slide-Valve Seat.**—The slide valve *3*, Fig. 4, works within a brass bushing *35*, the lower part of which is flat so as to form a seat for the valve. In Fig. 8, the bushing is shown sectioned so that the slide valve seat can be seen. The seat has four ports *r*, *t*, *y*, and *p* cut through it, which register with passages in the triple-valve body.

16. **Triple-Valve Body.**—A sectional view of a part of the triple-valve body is shown in Fig. 9. The purpose of this illustration is primarily to show passage *y* that leads from a chamber in the body and terminates in a port *y* in the slide-valve seat. The purpose of passage *y* is to reduce the pressure in the brake pipe and thereby quicken the application of the brakes when

they are applied in service on long trains. Port *r* in the slide-valve bushing leads to the brake cylinder because the auxiliary tube comes opposite the lower end of passage *r* at *d*. Port *p* leads to the exhaust port and the pressure retaining valve, and port *t* is drilled through the bushing and the valve body into the chamber below.

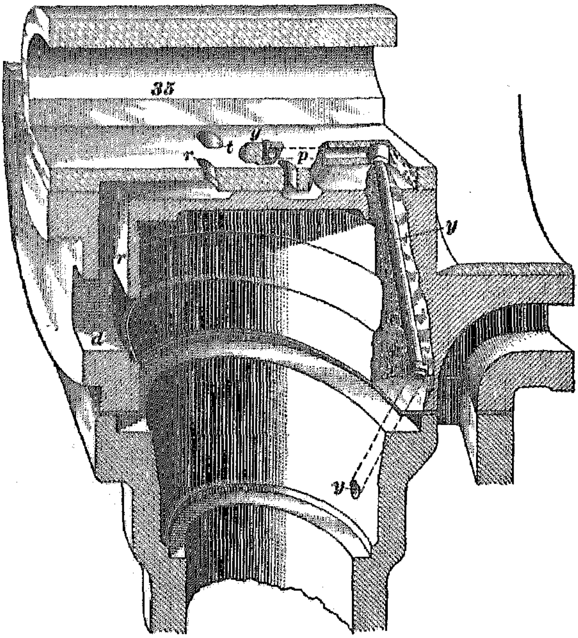


FIG. 9

17. Graduating Stem and Spring.—The purpose of the graduating stem, *21*, Fig. 4, when properly supported by the graduating spring *22* is to prevent the triple piston from moving to emergency position during a service application on a short train. It also stops the piston in quick-service position.

18. Emergency Parts.—The emergency parts of the triple valve as shown in Fig. 10 are the emergency piston *8*, shown sectioned, the emergency valve *10* with a rubber seat *11*; the brake-pipe check-valve *15*; the emergency-valve seat *9*; and the check-valve spring *12*.

The purpose of the emergency parts is to cause brake-pipe air to be vented to the brake cylinder in emergency-brake applications, *thereby transmitting* serial *quick action from car to car* throughout the train, and also to prevent the return of brake-cylinder air to the brake pipe.

The emergency-valve seat is of brass and is placed between the check-valve case *13*, Fig. 4, and the triple-valve body *2*. When assembled the rubber-faced emergency valve seats on the flange *a′*, Fig. 10, of the seat. The opening in the upper part of the seat acts as a guide for the emergency-piston stem, and

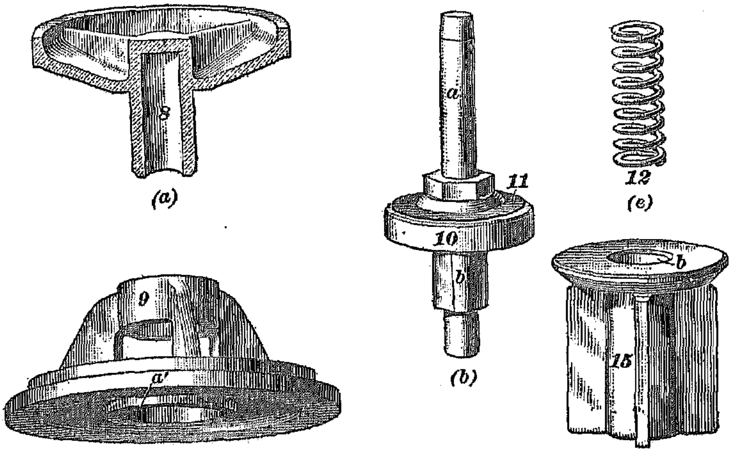


FIG. 10

the top of the upper part forms a stop for the emergency piston when it is forced downwards during an emergency application.

The purpose of the emergency valve is to prevent air from the brake pipe and chamber *y*, Fig. 4, from passing to the brake cylinder except in emergency. The stem *a*, Fig. 10 (*b*), of the emergency valve *10* extends into the hollow stem of the emergency piston *8*, and the piston rests on the upper part of the stem. A downward movement of the emergency piston will therefore unseat the emergency valve. In normal position, the lower rounded part of the stem *b* of the valve partly extends into a cavity *b* in the check-valve *15*; this cavity not only acts as a guide for stem *b*, but also as a receptacle for spring *12*.

The purpose of the check-valve *15* is to prevent a backflow of air from chamber *y*, Fig. 4, and the brake cylinder to the brake pipe, which would result in a loss of brake-cylinder pressure whenever the pressure in the brake pipe was lower than that in the brake cylinder, as happens when the brake pipe is depleted during emergency applications. Under such conditions, the brake-cylinder air would force the emergency valve down and pass to the brake pipe.

The purpose of the spring *12*, Fig. 10 (*e*), is to hold the emergency valve and check-valve in their normal positions, or seated when not being operated, and to return them as well as the emergency piston to their normal positions after an emergency application.

19. Retarding Device.—The retarding device is a very simple piece of apparatus, yet it performs an important function because, without it, a uniform release and recharge of the brakes could not be obtained.

As shown in the sectional view in Fig. 4, the retarding device consists of a retarding stem *31*, a retarding spring *33*, and a retarding-device body *29* that holds the stem and spring in position in the end of the triple valve.

The opening *e* in the body serves to connect the slide-valve chamber of the triple valve to the auxiliary reservoir. The threaded hole *b* permits a tool to be screwed in when the stem is being removed, should it stick. The purpose of the retarding device is either to stop the triple piston and slide valve in release position or to return these parts from retarded-release position to release position.

If the pressure in the brake pipe is less than 3 pounds higher than the pressure in the auxiliary reservoir, the retarding device acts as a positive stop, and prevents the triple piston from moving back any farther when it engages the stem *31*. The slide valve is then said to be in full-release position.

20. If the pressure in the brake-pipe exceeds the pressure in the auxiliary reservoir by more than 3 pounds, the push exerted by the end of the triple piston becomes more than the spring *33*, Fig. 4, can withstand. The retarding stem then moves

outwards and in so doing compresses the retarding spring *33*. The slide valve and triple piston are now carried to another position known as retarded-release position. Therefore, the triple valve has two release positions; namely, a full-release position and a retarded-release position.

When the end of the triple piston strikes the retarding stem and stops in full-release position as in the first instance, the position of the slide valve is such as to cause the auxiliary reservoir to recharge at the normal rate from the brake pipe, and the air from the brake cylinder to discharge in the usual time.

When the triple piston and the slide valve move all the way back as in retarded-release position, the change in the position of these parts causes the air to discharge more slowly from the brake cylinder, and also causes the auxiliary reservoir to recharge more slowly from the brake pipe than when the valve is in full-release position. However, when the difference between the pressure in the auxiliary reservoir and the brake pipe becomes less than 3 pounds, the retarding spring moves the parts back to full-release position.

It has been found that a pressure in the brake pipe of 3 pounds in excess of the pressure in the auxiliary reservoir cannot be obtained much more than thirty cars back of the engine. Accordingly, the triple valves on these cars assume a position in which the brakes release and recharge slowly, while behind about the first thirty cars, the release and the recharge occur at a normal rate.

It will be explained farther on how the action just described brings about a uniform release and recharge of all the brakes throughout the train.

AUXILIARY RESERVOIR AND BRAKE CYLINDER

21. An exterior view of the auxiliary reservoir and the brake cylinder used with the combined type K freight-car brake equipment is shown in Fig. 11. The equipment is attached to the car by bolts that pass through the holes in the brackets cast on the auxiliary reservoir and the brake cylinder. The small hole shown in the end of the auxiliary reservoir is the triple-valve end of the auxiliary tube, and when the triple valve is

bolted to the auxiliary reservoir the retarding device on the triple valve extends into the large opening shown.

In Fig. 12, the auxiliary reservoir and the brake cylinder are shown in section. The purpose of the auxiliary reservoir is to store compressed air for applying the brake on the car on which it is placed; the brake cylinder is used to convert the pressure of the compressed air into a force that acts through the foundation brake rigging on the brake shoes. The importance of the brake cylinder on the operation of the brake and the necessity for maintaining it so that no leakage exists, will be evident when it is recalled that the whole function and purpose of the air-brake system is to deliver and maintain certain air pressures in the brake cylinder.

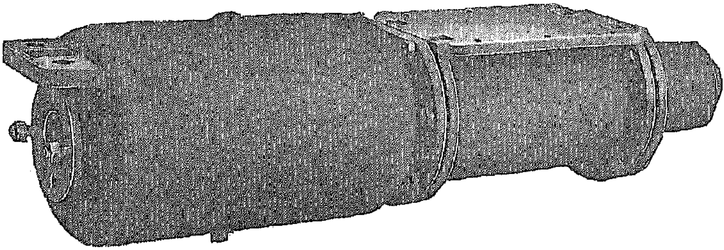


Fig. 11

The connection between the auxiliary reservoir and the brake cylinder when the brake is being applied, between the brake cylinder and the atmosphere when the brake is being released, and between the brake pipe and the auxiliary reservoir when the latter is being charged, is made by the triple valve.

22. The auxiliary reservoir is made of cast iron and of a size proportionate to the brake cylinder with which it is used. When used with an 8-inch freight-car brake cylinder, the auxiliary reservoir has an approximate volume of 1,650 cubic inches, and when used with a 10-inch brake cylinder, the volume of the auxiliary is 2,440 cubic inches. The triple valve is secured to the auxiliary reservoir by reservoir studs and nuts, two being used with a K-1 triple valve and a brake cylinder 8 inches in diameter, and three with a K-2 triple valve and a brake cylinder 10 inches in diameter. A gasket *15*, Fig. 12, is used to make an

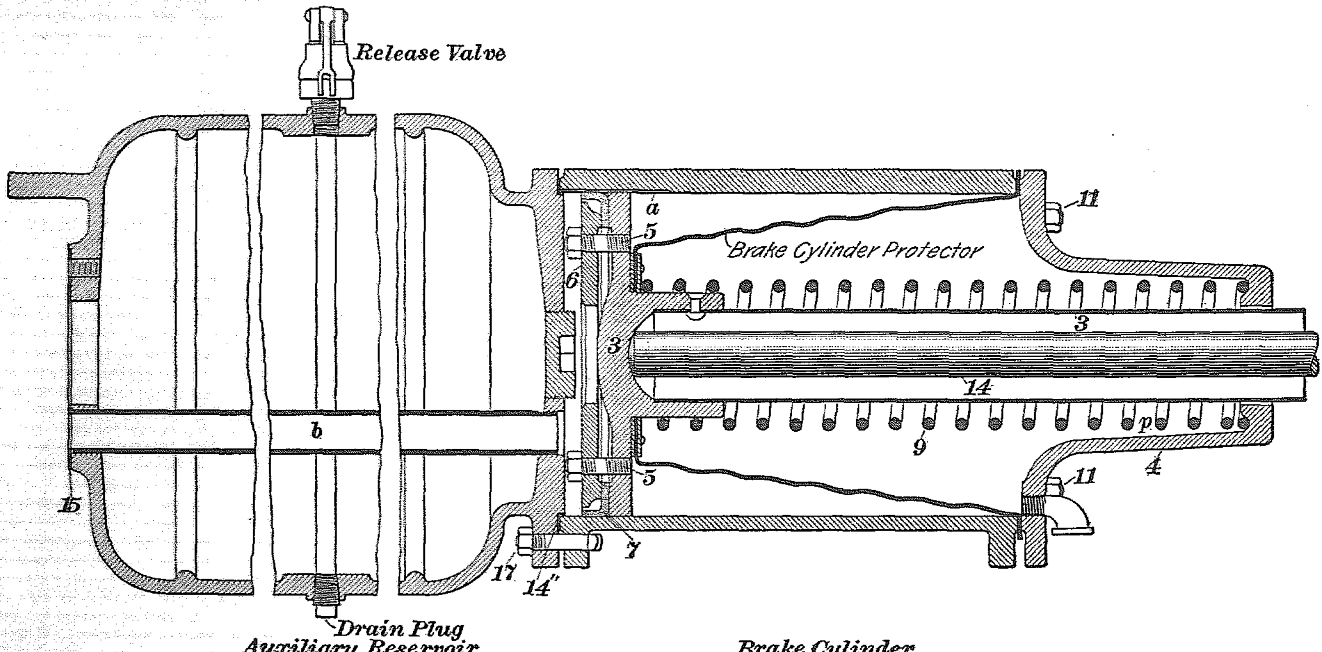

Release Valve
a
11
5
Brake Cylinder Protector
6
3
3
b
14
p
9
4
5
11
15
7
17
14"
Drain Plug
Auxiliary Reservoir
Brake Cylinder

FIG. 12

air-tight joint between the triple valve and the auxiliary reservoir. The auxiliary tube *b* is used to connect the triple valve to the brake cylinder. The purpose of the tube is to conduct the air from the auxiliary reservoir by way of the triple valve to the brake cylinder when applying the brake, and also to conduct the air from the brake cylinder when releasing the brake. The release valve is employed to discharge air from the auxiliary reservoir and release the brake when the engine is detached or when coupled, if the engineer cannot release it. When the valve is opened, the pressure on the auxiliary side of the triple piston is reduced, the higher brake-pipe pressure on the other side moves the piston and the slide valve to release position, and the air exhausts from the brake cylinder.

23. The brake cylinder contains a piston *3*, Fig. 12, with a hollow piston rod *3* riveted to it. The piston rod acts as a guide for the piston, it serves to keep the release spring *9* in its proper position during the movement of the piston, and it also serves to guide the push rod *14*. The inner portion of the push rod is merely inserted into the piston rod and is not connected to it in any way; the outer end of the rod is connected to the cylinder lever of the foundation brake rigging. The purpose of the push rod is to enable the hand brake to be applied without having to pull out the piston, the resistance of which is considerable. Therefore, when the hand brake is being set, the push rod draws part way out of the piston rod. When the air brake is applied, the piston and the push rod move out together.

The release spring forces the piston to release position when the air is exhausted from the brake cylinder. The push rod is then returned into the piston rod owing to the brake beams being returned by their weight to their normal or vertical position again.

The pressure head of the brake cylinder is formed by the end of the auxiliary reservoir. The non-pressure head *4*, which is attached to the brake cylinder by the cylinder-head bolts and nuts *11*, is so constructed as to form an extension or pocket *p*, which prevents the release spring *9* from closing solid in case of long piston travel. The piston is made to operate air-tight

by a packing cup *7*, clamped to the piston by the follower *6* and the studs and nuts *5*. Thus the packing cup is held firmly against the piston except on a part of its outer edge.

24. The brake cylinder is bolted to the auxiliary reservoir by reservoir-cylinder bolts and nuts *17*. The cylinder gasket *14''* is used to make an air-tight joint between the auxiliary reservoir and the brake cylinder. The distance between the pressure head of the brake cylinder and the brake cylinder piston *3*, when the brake is fully applied, is called the piston travel.

The leakage groove *a* is a shallow groove cut in the wall of the cylinder and a travel of about 2 inches is necessary before the piston moves beyond it. The leakage groove prevents unsupplied brake-pipe leakage from applying the brake. The brake-pipe leaks are ordinarily kept supplied by the action of the feed valve. Thus, should the triple valve move to service position, thereby closing its exhaust port, the air passing slowly from the auxiliary reservoir to the brake cylinder will pass through the leakage groove and the brake will not apply.

The exhaust port in the triple valve is open in release position and permits such air to escape as may leak into the brake cylinder.

Freight-car brake cylinders are either 8 inches or 10 inches in diameter and are of such a length as to permit of a piston travel of 12 inches. They are designated as 8 in.×12 in., or 10 in.×12 in.

The purpose of the brake-cylinder protector is to prevent the dirt and moisture that enters the brake cylinder through the opening where the hollow piston rod passes through the non-pressure head from being deposited on the walls of the cylinder. The exclusion of dirt from the brake cylinder reduces the wear on the packing cup and thereby lessens brake-cylinder leakage. The protector, a cone-shaped collapsible hood of waterproof fabric is flanged at the large end; the flange is held between the cylinder and the non-pressure head when the latter is applied. At the small end the protector is held against the piston by the release spring. The street ell permits the moisture to drain out.

Brake cylinder protectors are used to a greater extent in passenger-car brake cylinders than in freight-car cylinders.

OPERATION OF TYPE K FREIGHT-CAR BRAKE EQUIPMENT

25. Diagrammatic Views.—Owing to the number and the location of the ports in the K triple valve, it is difficult to illustrate the valve in its different positions by true sectional views. Therefore, the operation of the triple valve will be explained from the enclosed diagrammatic views, Figs. 13 to 20, in which all the ports and passages are shown in one plane.

26. Full-Release and Charging Position.—If, when releasing the brakes and charging or recharging the brake system, the pressure in the brake pipe cannot be raised high enough above the pressure in the auxiliary reservoir to force the triple piston *4*, Fig. 13, inwards and compress the retarding spring *33*, the triple valve will assume full-release and charging position.

The air from the brake pipe enters the triple valve and passes by way of the passage *a* to the chamber *b*. The air then passes through the feed groove *i* into the chamber behind the triple piston and enters the auxiliary reservoir through the opening in the retarding-device body. The brake cylinder is connected to the atmosphere through the auxiliary tube, passage *r*, cavity *n* in the slide valve *3*, and through passage *p* and port *Ex.* to the exhaust port in the retaining valve.

The air in passage *a* lifts the check-valve *15* against the tension of the spring *12* and charges the chamber between the check-valve and the emergency valve *10* with air at brake-pipe pressure.

There will be a pressure of 70 pounds to the square inch in the brake pipe and in the auxiliary reservoir when the brake system on the car is fully charged. Therefore, the triple piston is balanced between the equal pressure in the brake pipe and the auxiliary reservoir.

27. Quick Service.—The action of the triple valve in moving from full-release position, Fig. 13, to quick-service position, Fig. 14, is as follows: When the brakes are applied in service, the pressure in the brake pipe and in chamber *b*, Fig. 13, reduces more rapidly than the air can pass from the auxiliary reservoir through the feed groove *i* to the brake pipe. The triple piston *4*

is then moved outwards beyond the feed groove by the greater pressure in the auxiliary reservoir, thereby breaking the connection between the brake pipe and the reservoir. At the same time, the triple piston carries the graduating valve *7* forwards on top of the slide valve *3*, and opens port *z*, Fig. 14. The collar on the rear of the piston stem next engages the slide valve *3* and all of the parts move outwards until the piston is arrested by its knob striking the graduating stem *21*. The triple valve is now in quick-service position in which port *z* in the slide valve registers partly with part *r* in the valve seat. The air from the auxiliary reservoir passes by the end of the graduating valve *7*, through port *z* and port *r* to the brake cylinder, and moves out the piston; this action applies the brake. Cavity *n* in the slide valve is moved out of register with ports *r*, *p*, and exhaust port *Ex*. before port *z* connects to port *r*, therefore the air that enters the passage *r* cannot escape through passage *p* to the retaining valve.

The air in the check-valve chamber passes through passage *y*, port *o* in the slide valve, cavity *v* in the graduating valve, port *q* in the slide valve, and port *t* in the slide-valve seat, thence past the emergency piston *8*, which is a loose fit, to the brake cylinder. As soon as the pressure in chamber *y* reduces sufficiently below the pressure of the brake pipe in chamber *a*, the check-valve *15* lifts against the tension of the check-valve spring, and permits air from the brake pipe to pass through the ports just mentioned to the brake cylinder. The size and arrangement of these ports is such that the passage of air from the brake pipe to the top of the emergency piston is not sufficient to force it downwards and cause an emergency application.

However, enough air is taken from the brake pipe to cause a definite local reduction in brake-pipe pressure, which is transmitted to and repeated by each triple valve, thereby increasing the rapidity with which the brake-pipe reduction travels back through the train. The advantage of quick service is that, with the brakes applying rapidly, the action of the slack in producing shocks in the train is lessened because the more rapid application of the brakes prevents the slack from running in to the same extent as when the brakes apply more slowly.

28. The serial action of the brakes, or the action of one triple valve in assisting to apply the next by the venting of air from the brake pipe to the brake cylinder, is similar in principle to the serial action during an emergency application with the exception that less air is taken from the brake pipe. The operation of the brakes in emergency is referred to as serial quick-action application, and their operation in quick-service as serial quick-service application of the brakes.

The air that is taken from the brake pipe by the triple valves during quick service shortens materially the duration of the exhaust at the brake valve, and also gives a pressure in the brake cylinder, when the pressure in it and the auxiliary reservoir equalizes, about one pound higher than with the older type of triple valve.

The brake-cylinder pressure in chamber *r*, Fig. 14, cannot move the emergency valve *10* downwards because the greater pressure in chamber *y*, which is about equal to that in the brake pipe, assisted by the check-valve spring, holds the emergency valve up to its seat.

29. Quick Service Lap.—The purpose of lap position is to hold the brake applied until it is desired either to apply it harder or to release it. The operation of the triple valve in moving to lap position is as follows: In Fig. 14, port *z* is in partial register with port *r*, and the quick-service port *y* is in full register with port *o*, but more air can pass from the auxiliary reservoir through port *z* to the brake cylinder than can pass through the quick-service ports by way of passage *y*. Therefore, after the brake-pipe reduction ceases at the brake valve, the air in the auxiliary reservoir passes to the brake cylinder until finally the pressure in the reservoir to the right of the triple piston becomes less than the pressure in the brake pipe in front of the piston. When the difference of pressures becomes great enough to overcome the friction of the parts, the triple piston is moved inwards, by the greater pressure in the brake pipe, toward the lesser pressure in the auxiliary reservoir. The graduating valve is carried along with the piston until the collar on the piston strikes the slide valve. The triple piston then stops because there is not

a sufficient difference of pressures on it to move the slide valve, which therefore remains in quick-service position. The triple valve is now in quick-service lap position, Fig. 15. The graduating valve *7* closes port *z* and stops the passage of air from the auxiliary reservoir to the brake cylinder through this port, and the valve at the same time breaks the connection between ports *o* and *q*, and therefore stops the discharge of air from the brake pipe to the brake cylinder.

30. If it is desired to apply the brakes harder, a further reduction in the pressure in the brake pipe will cause the triple piston and the graduating valve to move to quick-service position again, and these parts will return to lap position as soon as the reduction in the pressure in the auxiliary reservoir approximates that made in the pressure in the brake pipe. Each succeeding reduction decreases the pressure in the auxiliary reservoir and increases the pressure in the brake cylinder. The pressure in these parts becomes equal at about 51 pounds if the piston travel is 8 inches, after a brake pipe reduction of 20 pounds from 70 pounds. The brakes now cannot be applied any harder, and they must be released and recharged.

31. The triple valve does not operate in quick service after the first brake-pipe reduction, provided this reduction is about 10 pounds. The reason is as follows: When the triple valve first moves to quick-service position, the air from the brake pipe passes freely to the empty brake cylinder and a serial service application of the brakes results. After a brake-pipe reduction of 10 pounds, which gives a brake-cylinder pressure of 25 pounds with standard piston travel, the pressure in the brake cylinder is now high enough to prevent the air from entering from the brake pipe rapidly enough to bring about a serial-service application of the brakes. However, some air passes from the brake pipe to the brake cylinder each time the parts of the triple valve move from quick-service lap position to quick-service position until the pressure becomes near enough equal to prevent any further flow of air.

The quick-service feature is not needed after the brakes are once applied because a lighter reduction in brake-pipe pressure

is required to move the triple pistons and graduating valves from quick-service lap position to quick-service position with the feed grooves closed and no back-flow of air, than is required to start these parts from release position when the feed grooves are open.

32. **Full Service.**—The triple valve is shown in full-service position in Fig. 16. On short trains, the service parts of the triple valve move to full-service position instead of to quick-service position, because, on account of the small volume of the brake pipe and the lesser friction of the air in the pipe, the air discharges more rapidly than with long trains.

The service parts of the triple valve assume momentarily quick-service position, but the air in the auxiliary reservoir cannot reduce in pressure by passing through the partly opened service port as fast as the pressure in the brake pipe reduces. The excess of pressure in the auxiliary reservoir then forces the triple piston outwards, compressing the graduating spring slightly, and the slide valve opens the service port *z* fully. The larger port opening between the auxiliary reservoir and the brake cylinder then permits the pressure in the reservoir to reduce more rapidly and keep pace with the more rapid reduction of pressure in the brake pipe. In full service position, port *o* in the slide valve has moved past the quick-service port *y*, therefore no air passes from the brake pipe to the brake cylinder.

The triple valves may also move to full service position on long trains. Thus, when the pressure in the brake cylinder becomes so high that the auxiliary air cannot flow in quite as fast as the pressure in the brake pipe is being reduced by the brake valve and the quick-service ports, the auxiliary pressure will force the triple piston and the slide valve forwards, the graduating spring will be compressed slightly, and the triple valve will then assume full-service position.

33. **Full-Service Lap.**—The triple valve is shown in full-service lap position in Fig. 17. The triple piston and the graduating valve assume lap position for the same reason that they move to quick-service lap; that is, when the pressure in the auxiliary reservoir reduces enough below the pressure in the brake

pipe for this latter pressure to overcome the friction of the triple-piston packing ring, and the graduating valve, the piston moves to the right until stopped by the collar striking the slide valve. The graduating valve *7* now closes the upper end of port *z*, and the brake is held applied because air is prevented from entering the brake cylinder. During further brake applications, the slide valve does not move, and the triple piston merely operates between full-service and full-service lap positions, thereby causing the graduating valve to open and close port *z*.

With a brake-pipe pressure of 70 pounds and a brake-cylinder piston travel of 8 inches, the brakes are applied fully when the pressure in the brake pipe has been reduced 20 pounds. There is then a pressure of 50 pounds in the brake pipe, the auxiliary reservoir, and the brake cylinder.

34. Uniform Release.—The uniform release of the brakes, by which is meant that all brakes release at about the same time, is brought about by providing the K triple valve with two release positions, a retarded-release position and a full-release position. The particular release position which the triple valve will assume, depends on the position of the valve in the train. The triple valves on about the first thirty cars in the train move to retarded-release position during a release because the pressure is raised more rapidly in this part of the brake pipe than at the rear. The reason for a slower increase in pressure at the rear is due to the friction encountered by the air in its passage to the rear of the train, and also to the fact that the auxiliary reservoirs at the front of the train begin to recharge and absorb air from the brake pipe.

When the pressure in the brake pipe on the first thirty cars becomes about 3 pounds higher than the pressure in the auxiliary reservoirs, each triple piston moves inwards and compresses its retarding spring *33*, as shown in Fig. 18, and the triple valves assume retarded-release position. The pressure in the brake pipe behind the first thirty cars cannot be raised 3 pounds higher than the pressure in the auxiliary reservoirs, and the retarding stem *31* and the spring *33* stop each triple piston and slide valve in full-release position, Fig. 13.

35. The effect when the triple valves on the front part of the train are in retarded-release position and on the rear in full-release position is to bring about a uniform release of all brakes. The reason is as follows: The air in the brake cylinder, and in passage *r*, Fig. 18, with the triple valve in retarded-release position can only escape slowly because, after entering cavity *n*, the air must pass through restricted port *x* before it can enter cavity *m* and pass to the atmosphere through port *p* and the exhaust port *Ex*. However, on the rear cars, as shown in Fig. 13, the connection between the brake cylinder and the atmosphere is made through cavity *n* only, and the air escapes at the normal rate.

36. The result of the brakes beginning to release first on the front of the train through a small port, and to release next on the rear of the train through a larger opening is to bring about a uniform release of the brakes throughout the whole train. A simultaneous release of the brakes permits of a release at low speeds without danger of a severe shock or a break-in-two.

The triple valves that are in retarded-release position will remain in this position until the pressure in the brake pipe and in the auxiliary reservoir becomes near enough equal for the retarding springs *33*, Fig. 18, to overcome the friction of the triple pistons and the slide valves. When this occurs, the springs force these parts to full-release and charging position as shown in Fig. 13.

The triple valves in retarded-release position at the point where the difference between the pressure in the brake pipe and the pressure in the auxiliary reservoirs is the least will return from retarded-release to full-release position first, because the rquired difference in the pressures necessary for the movement of the parts is obtained there sooner than where the difference in the pressures is greater. Therefore, the movement of the triple valves to full-release position begins at about thirty cars back and proceeds to the front of the train, where the pressure in the brake-pipe is the highest.

37. Uniform Recharge.—A uniform recharge of the auxiliary reservoirs occurs at the same time as a uniform release of

the brakes and is brought about in the folowing manner: With about the first thirty triple valves on the front part of the train in retarded-release position, Fig. 18, the air from the brake pipe can only recharge the auxiliary reservoirs through the small feed groove *e* (also see Fig. 5) in each one. The triple valves on the cars behind about the first thirty are in full-release position as shown in Fig. 13, and the reservoirs charge through the feed grooves *i*, which are considerably larger than the feed grooves *e*, Fig. 18.

Although the pressure is higher in the front part of the brake pipe, yet the small feed grooves *e*, prevent the auxiliaries on this part from charging faster than the rear auxiliaries through the large feed grooves *i*, Fig. 13. The combination of high pressure and small feed grooves on the front part of the train, and low pressure and large feed grooves on the rear, brings about practically a uniform recharge of the auxiliary reservoirs throughout the whole train. A uniform recharge prevents a reapplication of the head-end brakes by the air moving to the rear of the train after the brake valve is returned to running position.

38. **Emergency.**—The type K triple valve is shown in emergency position in Fig. 19. Emergency or quick action is brought about by a sudden and considerable reduction in the pressure in the brake pipe below that in the auxiliary reservoirs, no matter how caused. As a result, the movement of the parts of the triple valve is so rapid that there will be no time for the air to pass from the auxiliary reservoir to the brake cylinder through the service port *z* in the slide valve and the triple piston *4* will force back the graduating stem and spring and will seat firmly against the gasket in front of it. In this position, a slot *b*, Fig. 6 (*a*), in the slide valve *3* uncovers the emergency port *t*, Fig. 19, in the seat, and the air in the auxiliary reservoir passes down on top of the emergency piston *8*, and forces it downwards, thereby unseating the emergency valve *10*. The air in chamber *y* passes to the brake cylinder, and the brake-pipe air in chamber *a* raises the check-valve *15* and passes by way of the unseated emergency valve and the auxiliary tube, to the brake

cylinder. The air in the auxiliary reservoir passes to the brake cylinder through port *s*.

39. When the pressure in the brake pipe and the brake cylinder nearly equalize, the check-valve spring seats the check-valve *15*, Fig. 20, and prevents the back-flow of air from the brake cylinder to the brake pipe in which the pressure finally reduces below the pressure in the brake cylinder. The emergency valve *10* is held open by the emergency piston *8* and will return to its seat when the pressure in the auxiliary reservoir above the piston and the pressure in the brake cylinder below the piston have nearly equalized.

The sudden discharge of brake-pipe air into the brake cylinder affects the next triple valve in the same manner as if the air were discharged to the atmosphere. In this way, each triple valve applies the next, and the transmission of quick action is so rapid that it requires less than 3 seconds to apply the brakes on a train of fifty cars. Owing to the air that is admitted from the brake pipe, the brake-cylinder pressure is about 10 pounds higher with standard piston travel after an emergency application than after a full-service application.

The joint made when the triple piston is forced against the gasket prevents any air that passes by the triple-piston packing ring from escaping into the brake pipe.

Owing to the amount of brake-pipe air that is vented to the brake cylinders in emergency, the discharge of air at the brake valve virtually stops after the first triple valve moves to emergency position.

DISORDERS

40. **Common Disorders.**—The common disorders to which the K triple valve, Fig. 13, is subject are as follows: Leaky slide valve *3*, leaky graduating valve *7*, leaky triple-piston packing ring, leaky check-valve case gasket *14*, leaky emergency valve *10*, defective graduating spring *22*, broken retarding spring *33*, leaky triple-valve body gasket *11*, and a leaky auxiliary tube.

The effect of the foregoing disorders on the operation of the brake can be more readily understood by remembering that a

reduction of brake-pipe pressure below the pressure in the auxiliary reservoir will cause a brake to apply, and that a reduction of auxiliary-reservoir pressure below the pressure in the brake pipe will cause a brake to release. However, when considering a disorder that reduces the pressure in the auxiliary reservoir, the leakage from the brake pipe must always be taken into account, because such leakage may modify or change entirely the effect of a leak from the auxiliary reservoir. For example, a leaky graduating valve will cause the air from the auxiliary reservoir to continue to pass to the brake cylinder if the brakes are applied lightly. With a tight brake pipe, the brake would release, but as the brake pipe always leaks, the action that will occur will depend on whether the brake-pipe pressure is reducing faster or slower than the pressure in the auxiliary reservoir.

41. Leaky Slide Valve.—A leaky slide valve *3*, Fig. 13, permits the air from the auxiliary reservoir to leak into the ports *p* or *r*, and causes a blow at the exhaust port of the pressure retaining valve, whether the brake is applied or not. This leak tends to release the brake because it reduces the pressure in the auxiliary reservoir below the pressure in the brake pipe. However, brake-pipe leakage may prevent the triple piston from moving the slide valve to release position.

42. Leaky Graduating Valve.—With a leaky graduating valve *7*, Fig. 13, the air will continue to pass from the auxiliary reservoir to the brake cylinder, after the valve has moved to lap position. The brake, if only partly applied, may release, provided the leaks in the brake pipe are not too great.

43. Leaky Triple-Piston Packing Ring.—A leaky triple-piston packing ring tends to prevent the formation of the required difference between the pressure in the brake pipe and the auxiliary reservoir for the operation of this brake. For example, the brake will not apply if the leak is great enough to keep the pressure in the auxiliary reservoir equal to that in the brake pipe. Neither will the brake release if the leak prevents the brake-pipe pressure from building up enough on this triple piston to move it to release position.

A leaky packing ring affects the release of a brake to a greater extent than its application. The reason is that the brake-pipe leaks assist the reduction when the brakes are being applied, but tend to prevent the required increase in pressure necessary for a release.

A triple valve with a leaky packing ring may release if on or near the head end of a long train, but, owing to the slow increase in brake-pipe pressure, may not release if in the rear portion of the train.

44. Leaky Check-Valve Case Gasket.—A leaky check-valve case gasket *14*, Fig. 13, that allows brake-pipe air to enter chamber *x* will cause a blow at the exhaust port of the pressure retaining valve when the triple valve is in release position because the air will pass to the exhaust port *Ex*. Also, the brake will apply harder when set with a light application because the leak not only reduces the pressure in the brake pipe and thereby causes a flow of air from the auxiliary reservoir to the brake cylinder, but the leak also increases the pressure in the brake cylinder. A leak through the gasket to the atmosphere affects the brakes the same as a leak from the brake pipe.

45. Leaky Emergency Valve.—The effect of a leak at the rubber seat of the emergency valve *10*, Fig. 13, is the same as if the gasket *14* leaks. In release position, the air from the brake pipe escapes through passage *r*, cavity *n* in the slide valve, port *p*, and the exhaust port *Ex.*, and causes a blow at the exhaust port of the retaining valve. When the brakes are applied lightly, the leak increases the pressure in the brake cylinder to an extent that depends on the leak, the volume of the brake pipe, and the length of time that the brake is held applied. With the brake applied fully, the brake-cylinder pressure in chamber *x* is equal to the pressure in the brake pipe and no leak will occur.

A leaky emergency valve frequently results in a buzzing noise in the triple valve. This is because the leak causes the check-valve *15* to chatter or to unseat and seat very rapidly. The check-valve unseats when the leak reduces the pressure in the chamber above the check-valve the required amount below the

pressure in the brake pipe, and seats again when the pressure in the chamber is restored to the proper amount.

If the emergency valve is held open by the emergency piston sticking after an emergency application, the brake will remain applied because the air from the brake pipe can pass the valve to the brake cylinder faster than it can escape at the exhaust port of the pressure retaining valve. Sometimes the emergency parts can be made to assume normal position by tapping the check-valve case, but if not, the cut-out cock should be closed, the auxiliary reservoir should be drained, and the cock then opened quickly. The rush of air against the bottom of the valve will usually drive it up to its seat. If the blow does not stop, the cut-out cock should be closed, thereby cutting the brake out, and the release valve should be blocked open.

46. Defective Graduating Spring.—The purpose of the graduating stem, when properly supported by the graduating spring *22*, Fig. 13, is to prevent the triple piston from moving to emergency position during a service application on a short train. If the spring is broken or is too weak to stop the service parts of the triple valve in service position, and, if the train is short, these parts will move to emergency position.

However, on a long train, a defective graduating spring will not cause undesired quick action. The reason is as follows: When the slide valve and the graduating valve move to service position, the air from the auxiliary reservoir begins to discharge to the brake cylinder. Whether the slide valve will be moved by the triple piston beyond service position and begin to close the fully opened service ports and thereby restrict the passage of air from the auxiliary reservoir to the brake cylinder, depends on whether the brake-pipe or the auxiliary-reservoir pressure reduces the more rapidly. A short brake pipe contains a comparatively small volume of air and the pressure is reduced at the brake valve at a greater rate than the pressure in the auxiliary reservoir is reduced through the fully opened service ports. As soon as a sufficient difference in pressure is formed, the triple piston moves forwards and the slide valve begins to partly close the service port. The pressure in the auxiliary reservoir then

becomes enough higher than the pressure in the brake pipe to force the triple piston and the slide valve to emergency position. With a long train, the volume of the air in the brake pipe and the frictional resistance to its movement are so much greater that the pressure in the brake pipe cannot be reduced at the brake valve any faster than the pressure in the auxiliary reservoir is reduced through the service ports of the triple valve. The brake-pipe and the auxiliary reservoir pressures remain about equal, and a sufficient difference of pressure is not formed after service position is reached to move the parts of the triple valve to emergency position.

47. Broken Retarding Spring.—A broken retarding spring *33*, Fig. 13, permits the triple piston and slide to move always to retarded-release position, and this brake will release slowly.

48. Leaky Triple-Valve Body Gasket.—The triple-valve body gasket *11*, Fig. 13, is designed to make an air-tight joint where the triple valve fits against the end of the auxiliary reservoir. A leak through the gasket into chamber *x* will cause a blow at the exhaust port of the pressure retaining valve when the triple valve is in release position. The brake will have a tendency to release when applied with less than a full application because the air from the auxiliary reservoir will pass to the brake cylinder and will reduce below the pressure in the brake pipe.

A leaky gasket causes no bad effect when the brake is fully applied because the pressure in the auxiliary reservoir is then equal to the pressure in the brake cylinder. A leak through the gasket to the atmosphere tends to release the brake whether partly or fully applied.

49. Leaky Auxiliary Tube.—A leaky auxiliary tube, Fig. 13, has the same effect on the operation of the brake as a leaky gasket *11*. The leak causes a blow at the exhaust port of the pressure retaining valve when the brake is released, and will tend to release a brake when applied with less than a full application.

50. Leaky Brake-Cylinder Packing Leather or Gasket. Should the brake-cylinder packing cup *7*, Fig. 12, or the gasket *14″* leak badly enough, the brake will not apply in service. The brake will apply in emergency, owing to the more rapid inflow of air, and will then leak off.

51. Weak or Broken Release Spring.—A weak or broken release spring *9*, Fig. 12, is indicated by the failure of the piston rod *3* to move all the way back into the cylinder when the brake is released.

BLOWS

52. Causes for Blows.—Certain disorders when the triple valve is in release position permit air to pass through the exhaust port and thence to the pressure retaining valve and cause a blow. The source of the leak can only be from the auxiliary reservoir or from the brake pipe.

There are five causes for a blow at the exhaust port of the retaining valve; three of these causes permit the escape of air from the auxiliary reservoir, and two permit the escape of air from the brake pipe.

If the escape of air is from the auxiliary reservoir, the leak may be past the slide valve *3*, Fig. 13, or through the gasket *11*, or the auxiliary tube. If from the brake pipe, the leak may be due to a defective rubber seat on the emergency valve *10*, or to a leaky check-valve case gasket *14* that allows the air from the brake pipe to enter chamber *x*.

53. Locating the Leak.—To determine whether the leak is from the brake pipe or from the auxiliary reservoir, the brake should be cut out by closing the cut-out cock in the branch pipe. The leak is from the brake pipe if the brake applies and the blow stops. If the blow continues and the brake does not apply, the leak is from the auxiliary reservoir.

The brake applies and the blow stops with a leak from the brake pipe because, with the cut-out cock closed, the air from the brake pipe that has been supplying the leak is cut off. The leak then reduces the pressure and causes the triple piston to move the slide valve to service position, thereby breaking the connection between the brake cylinder and the atmosphere.

RELEASING A BRAKE

54. Purpose of Release Valve.—The purpose of the release valve, Fig. 13, on the auxiliary reservoir is to discharge air from it, and thereby release the brake when the locomotive is detached, or when coupled in case the engineer is unable to release the brake. When the release valve is opened, the pressure is reduced on the auxiliary-reservoir side of the triple piston, and the now higher pressure in the brake pipe moves the triple piston and the slide valve to release position and the air exhausts from the brake cylinder.

55. Arrangement.—The handle *c*, Fig. 13, of the release valve rests in a slot in the release-valve cylinder, and is held there loosely by the pins *d*.

A rod of sufficient length to reach to the side of the car is pinned to each arm of the handle. When either one of the rods is pulled the pin *d* nearest to that rod acts as a fulcrum for the handle, the central portion of which then moves down and unseats the rubber-faced vent valve *e*. The air then escapes from the auxiliary reservoir through the exhaust port *f*, and the triple valve moves to release position. The spring shown seats the vent valve when the rod is released. Two rods are provided so that the valve can be opened from either side of the car.

56. Releasing a Stuck Brake.—A brake is said to be stuck when it cannot be released in the ordinary way by increasing the pressure in the brake pipe. When releasing a stuck brake with the brake pipe charged, the release valve should be held open only until the exhaust of the air is heard to start. In this way, the pressure in the auxiliary reservoir is reduced only slightly below that in the brake pipe, and the triple piston and slide valve will stop in full-release position. If the release valve is held open longer than this, the pressure in the auxiliary reservoir will be reduced so much below that in the brake pipe, that the triple valve will assume retarded-release position, and the brake will release very slowly.

If the brake pipe is open to the atmosphere, the triple valve will be in emergency position, and the brake will have to be released by holding the release valve open until all of the air has escaped from the auxiliary reservoir. The action during a release at this time is as follows: The auxiliary reservoir and the brake cylinder are connected in emergency position and the pressure therein reduces when the release valve is opened until the graduating spring finally forces the triple piston and the slide valve back and breaks the connection between the auxiliary reservoir and the brake cylinder. The pressure in the reservoir then alone continues to reduce until the air in the brake cylinder is able to lift the slide valve against the resistance of its spring, and escape at the triple-valve exhaust port. If the pressure in the brake cylinder is not sufficient to lift the slide valve, the brake-cylinder piston is by this time generally far enough back to open the leakage groove and allow the air that remains in the brake cylinder to escape.

57. Cutting Out a Brake.—When it becomes necessary to cut-out a brake, the cut-out cock in the crossover pipe should be closed, and the air then drained out of the auxiliary reservoir by opening the release valve. The release valve should then be blocked open by wedging the rod where it passes through its keeper on the side of the car.

58. Slow Release.—A noticeable feature of the K triple valve is the slow release of the brakes under certain conditions due to the fact that the valve has two release positions, a full or normal release and a retarded or slow release. The release obtained depends on the manner in which the brake-pipe pressure is increased. If the pressure is increased slowly, the brakes will release quickly; if increased quickly, the brakes will release slowly. On short trains and in switching, the brake-pipe pressure can be increased rapidly; therefore, to avoid a slow release of the brakes, the handle of the brake valve should be returned from full-release position to running position sooner than otherwise. When this is done, the triple valves will stay in full-release position instead of moving to retarded-release position.

It can be determined whether the brake is stuck or whether it is in retarded-release position by noting whether air is escaping at the retaining valve. If so, the triple valve is in retarded-release position, and the release cannot be hastened by opening the release valve.

UNDESIRED QUICK ACTION

59. Undesired quick action means that a triple valve operates in emergency when a service application is made and thereby causes all the brakes to apply in emergency. There are many causes for undesired quick action, but whatever the cause, they all bring about a condition that prevents the pressure in the auxiliary reservoir from being reduced at about the same rate as the pressure in the brake pipe, the difference in pressure finally becoming so great as to force the parts past service to emergency position.

An emergency application of the brakes when a service application is made, is generally due to the slide valve being too hard to start. Therefore, the brake-pipe pressure reduces while the pressure in the auxiliary reservoir remains practically at standard pressure. The triple piston moves when the difference between the two pressures is sufficient to overcome the friction of the parts, but the movement of the slide valve is now so rapid that the air in the auxiliary reservoir does not have time to reduce through the service port while the slide valve is moving over it. The unreduced auxiliary-reservoir pressure then forces the triple piston forwards, compressing the graduating spring, and the slide valve is pulled to emergency position.

The lubrication of the slide valve and its seat with oil or grease, as this tends to seal the valve to its seat, is a common cause of undesired quick action. Dirt and gum in the triple valve also cause the parts to move less easily and induce undesired quick action. Brake-pipe leaks, especially if near the triple valve as in the cross-over pipe, may supplement a service reduction to such an extent as to cause quick action.

HOSE AND COUPLINGS

60. Construction of Hose and Coupling.—Fig. 21 (*a*) shows an air hose and coupling complete, consisting of a hose *a*, and a hose coupling *b* that includes a hose-coupling gasket *2* and a hose nipple *c*. An air hose is connected to the brake pipe at each end of a car, the purpose being to make, when coupled, a flexible and air-tight connection between the brake pipes on adjacent cars.

The hose nipple screws into the angle cock on the brake pipe, and the hose coupling, when coupled to the hose coupling on the next car, is designed to make a practically air-tight connection between the two hose. The hose is secured to the hose coupling and hose nipple by hose clamps *d*, and hose-clamp bolts and nuts.

61. Coupling the Hose.—Views (*b*), (*c*), and (*d*), Fig. 21, show the operation of coupling two hose together. In view (*b*) are shown the two couplings being raised to position to begin the coupling, in view (*c*) the coupling being started, and in view (*d*) the coupling completed.

Placing the couplings together as shown in view (*b*) brings the hose-coupling gaskets *2* in each coupling squarely over each other and also brings lugs *e* on each coupling on the inside of lugs *f*. The two couplings are then pressed firmly together endwise, and are rotated by pulling downwards, until the lugs *e* strike the stop pins *g*, view (*d*), the coupling movement being assisted by the tendency of the hose to assume their normal positions. Failure to couple the hose properly distorts the coupling gaskets and forces their flanges out of the grooves, thus causing leakage.

62. The outer ends of lugs *f* flare outwards slightly and the outer ends of lugs *e* inwards, the effect being to draw the two couplings together in a wedging movement when the coupling is being made, thereby bringing the face of gasket *2* in each coupling firmly against each other and thus preventing leakage. View (*e*) is a sectional view of two hose couplings connected. The hose-coupling gaskets *2* fit in grooves in each of

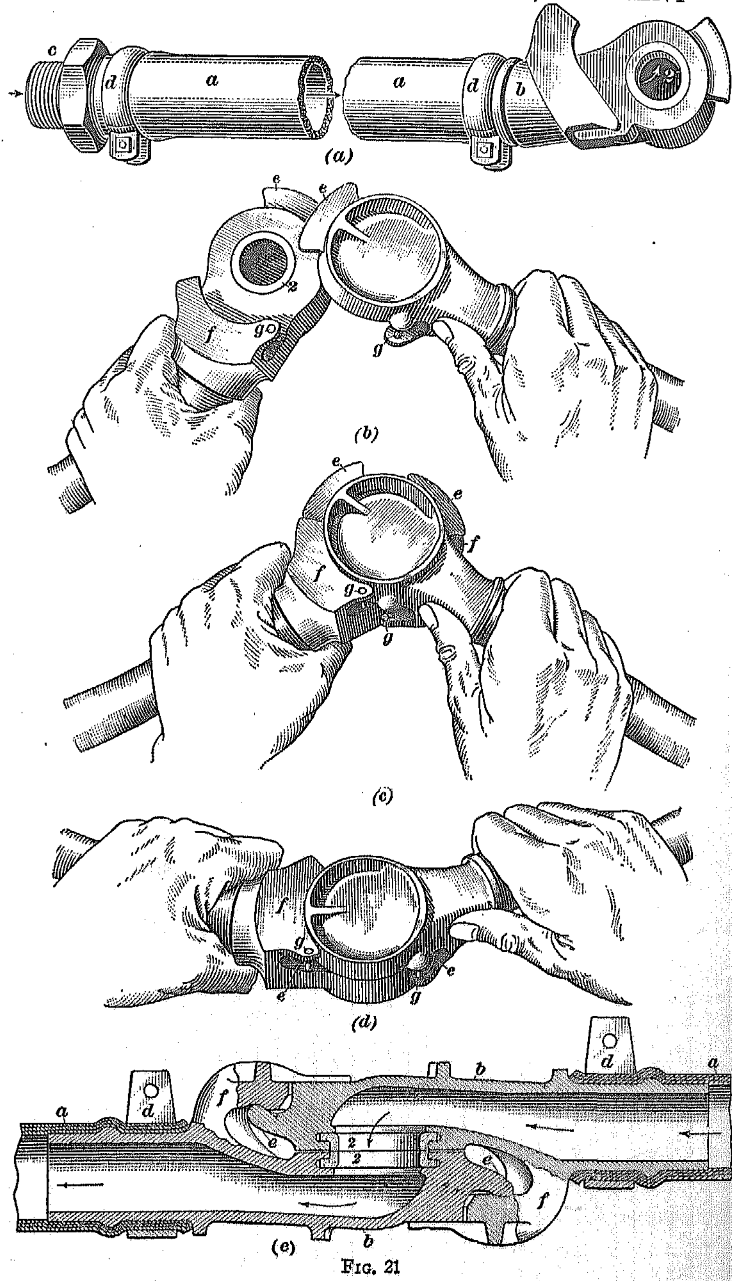


FIG. 21

the couplings. This view also shows how the outer faces of lugs *e* on the couplings bear against the inner faces of lugs *f*.

63. **Replacing Hose and Gaskets.**—In replacing defective air hose, care should be taken to have the faces of the couplings come together without twisting the hose. When a new hose-coupling gasket is applied, the groove in the coupling should be well cleaned, and the flanged part of the gasket then placed in the groove and applied evenly all the way around. A cleaning tool is furnished for applying new gaskets, the point being used to clean the groove and the handle to apply the gasket properly in the groove.

Air hose should always be uncoupled by hand; for leaving them coupled to be pulled apart by the separation of the cars springs the lugs on the couplings and causes leakage at the gaskets, as they are not then pressed firmly together when the hose are coupled. Couplings should not be hammered together to stop leakage, as this will prevent them from separating at this point in the event of a break-in-two, the result being that either the hose or brake pipe will be torn off.

ANGLE COCK

64. **Purpose.**—The purpose of the angle cock is to close off the brake pipe on a car when the end on which the cock is located is to be an end of the train, or to close off the brake pipe on the locomotive when it is to be operated singly. In Fig. 22 (*a*) is shown an exterior view of an angle cock with a self-locking handle, and in (*b*) is a sectional view. This type of angle cock is standard for all air-brake equipments. The handle is locked in both open and closed positions, and therefore cannot be accidentally moved.

65. **Names of Parts.**—In view (*b*), *2* is the body; *3*, the key; *4*, the handle; *5*, the spring; and *6*, the cap. The key is tapered and the spring *5* holds the key tight in its bush. A slot in the key registers with a slot in the bush when the angle cock is open, as shown, but when closed the two slots do not register and the passage of air is prevented.

In view (a) the key *3* that controls the passage of air through the angle cock is operated by a handle *4*, the handle being attached to the key by a pin a. The movement of the handle is imparted to the key by means of a lug b (on the key) that operates within a slot c in the handle. Lugs e and e' on the body act as stops for lug b when the key is rotated by the handle. Lugs e and e' also act in combination with two lugs f and f' on each side of the handle *4* to hold the handle locked.

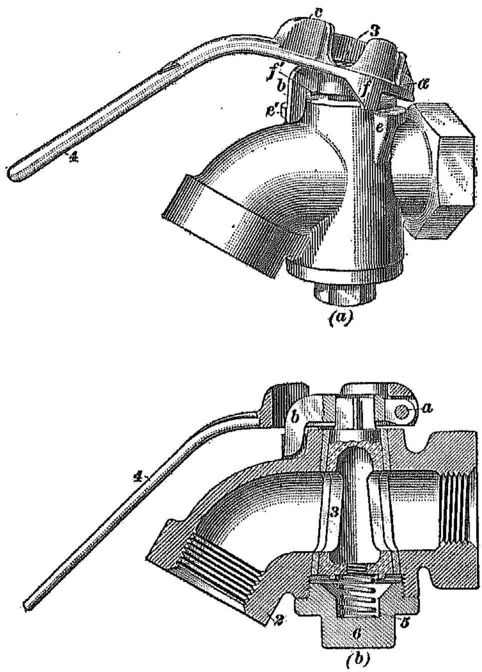


FIG. 22

66. Operation.—In view (a) the handle is shown raised and is in a position to move the key *3*, as lug f clears lug e; but when the handle is lowered, lug f engages lug e, thereby preventing the handle from being moved to closed position. Raising the handle and turning it crosswise of the pipe rotates the key *3* and brings lug b against lug e. Lowering the handle causes lug f', which is similar in form to lug f, to fall in front of lug e'. The handle is thereby locked in closed position.

THE BRAKE CYLINDER

67. **Leaks.**—The brake cylinder is used to convert the power of the compressed air into force, which acts on the brake shoes through the foundation-brake rigging. Brake-cylinder leaks should, therefore, be kept at a minimum, as they reduce the brake-cylinder force. The piston travel should be maintained within the prescribed limits, or not less than 7 inches or more than 9 inches, because a long piston travel also reduces the brake-cylinder force, whereas a short travel causes the brake-cylinder force to be exceeded. Leaks from the brake cylinder usually occur past the piston packing cup, and are caused by gum, grit, and lack of lubrication, or by wear. Leaks may also occur past the gasket between the brake cylinder and the auxiliary reservoir, past the gaskets *11* or *14*, Fig. 13, or in the piping between the auxiliary reservoir and the brake cylinder when the detached equipment is used.

A leak from the brake cylinder at any of the above points reduces the brake-cylinder pressure and causes the brake to *leak off*. The term *release* is not used in this connection, as it refers to a release of the brake when the triple valve goes to release position, but when the brake leaks off the triple valve remains in lap position.

68. **Effect of Unequal Piston Travel.**—If the piston travel in two brake cylinders is unequal, the pressure in the brake cylinder with the long piston travel will be less than the pressure in the one with the shorter travel. The reason is that the same volume of air enters both cylinders when the brakes are applied, but the pressure will be less with the long travel because the air has more space in which to expand. The piston travel on a car when the brake is applied should not exceed the prescribed travel, which is between 7 and 9 inches.

69. **Judging Brake-Cylinder Efficiency.**—The efficiency of the brake cylinder in transmitting pressure can be judged by the appearance of the brake shoes and wheel treads. If the brake-shoe treads have a scratched appearance and the brake shoes show signs of recent wear, the indications are that the brake

cylinder is retaining its pressure and is transmitting it to the shoes. After going down a grade, if the brakes were in good condition, the brake shoes would show the effect of heat, the edges near the wearing surfaces being either a dull black or a rusty red.

The brake shoes will show little or no indication of wear or heat, and may even have oil or dust on their faces, if the brake cylinder leaks or if the piston travel is excessive. The wheel treads will be polished instead of having a more or less scratched appearance when the brakes hold well.

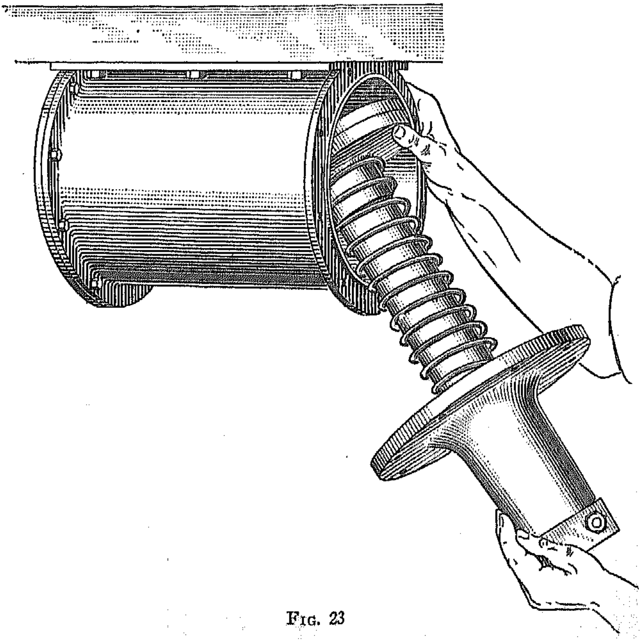


Fig. 23

70. Stopped-Up Leakage Groove.—If the brake-pipe leaks are not properly supplied by the feed-valve, the triple valve may move to service position. The air that enters the brake cylinder would ordinarily escape past the piston were the leakage groove open, but as the groove is closed the piston is forced out and the brake creeps on. This disorder also causes the brake to apply when the car is detached as in switching.

71. Replacing the Piston.—To replace the piston in a horizontal brake cylinder, keep the piston as near vertical as conditions will permit and allow it to enter the cylinder edgewise as shown in Fig. 23. Then raise the piston sleeve slowly and force the piston into the cylinder until the upper portion of the packing engages the cylinder wall. This part of the packing cup should be pressed into the cylinder by a dull-edged instrument

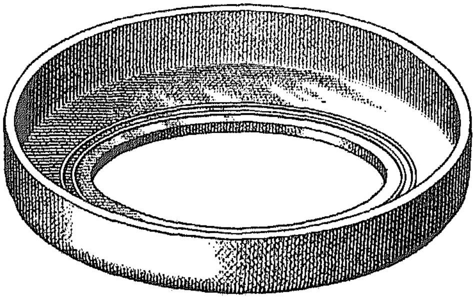


FIG. 24

while the sleeve is being raised, care being taken not to damage the cup or allow it to be turned back. Then pull upwards and outwards on the rod so as to be sure that the packing cup will not be doubled back. The piston should be pushed about halfway in and rotated in all directions about 3 inches from the center. If it binds, the cup is out of place and the piston must be removed and replaced. A view of Westinghouse brake cylinder packing cup is shown in Fig. 24.

If the slide valve of the triple valve has the brake-cylinder exhaust port closed, the brake-cylinder piston cannot be forced in because of a cushion of compressed air. To move the slide valve to release position and by so doing open the exhaust port, remove the cylinder-cap nut and the graduating stem and spring, then insert a small rod and push the triple piston back. The nonpressure head should be replaced after the piston has properly entered the cylinder.

PRESSURE-RETAINING VALVES

72. Purpose.—In order to charge the auxiliary reservoirs, it is necessary that the triple valves be in release position, and this position of the triple valves connects the brake cylinders to the atmosphere. Therefore, under ordinary conditions the charging of the auxiliary reservoirs and the release of the brakes occur at the same time.

In grade service, it is necessary, in order to control the speed of trains, to retain pressure in the brake cylinders and thus hold the brakes applied, when recharging the auxiliaries after brake applications. The purpose of the pressure-retaining valves when cut in is to cause a slow discharge of air from the brake cylinders down to a predetermined pressure and then to retain this pressure when the triple valves are in release position and the auxiliary reservoirs are being recharged. The pressure retained in the brake cylinder depends on the type of retaining valve used, and varies from 10 to 50 pounds.

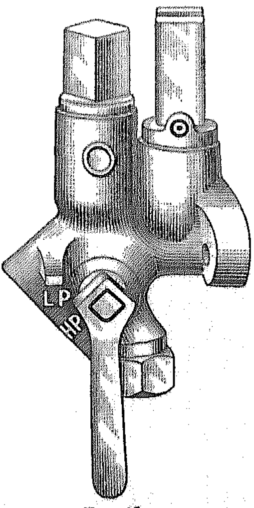


Fig. 25

The pressure-retaining valve performs no function when in its cut-out position, that is, when the handle is turned down, as it then permits the brake-cylinder air to be discharged freely to the atmosphere.

The retaining valve is piped to the exhaust port of the triple valve and is located at the end of the car within easy reach of the trainmen when the train is in motion and is connected by a pipe to the exhaust opening in the triple valve. When about to descend a grade, the trainmen pass over the train and cut in as many pressure-retaining valves as are necessary by turning up their handles. At the bottom of the grade, the handles are turned down again.

73. Description.—The standard retaining valve for freight cars is a three-position 10–20-pound duplex spring-type valve

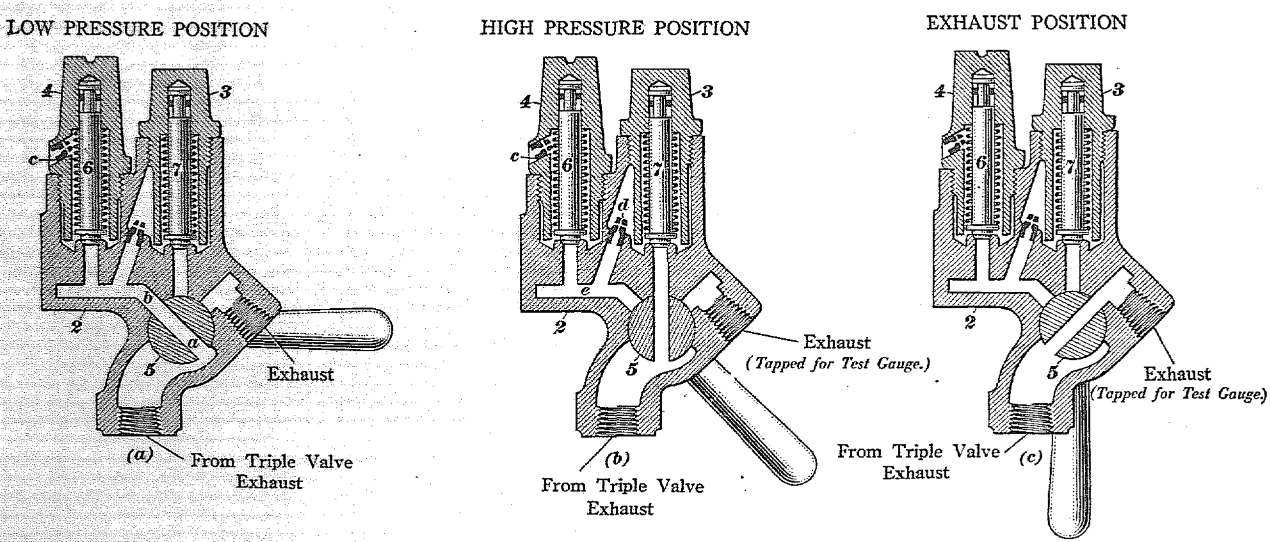

LOW PRESSURE POSITION
HIGH PRESSURE POSITION
EXHAUST POSITION
4
3
c
6
7
d
b
e
2
a
5
Exhaust
(Tapped for Test Gauge.)
(a)
(b)
(c)
From Triple Valve Exhaust

FIG. 26

with a nominal blow-down value of 50 seconds in the 10-pound position and of 90 seconds in the 20-pound position. A perspective view of the valve is shown in Fig. 25, and three diagrammatic views are given in Fig. 26.

The valve consists of a body *2*, a cap nut *3*, a vented cap nut *4*, a cock key *5*, operated by a handle, and two valves *6* and *7* supplied with springs of a tension of 10 pounds each. The springs and the valves are permanently enclosed in the cap nuts by pins, thereby preventing the possibility of spring distortion and also insuring permanent closing values.

74. Operation.—When the cock key is turned to the horizontal or low-pressure position, Fig. 26 (*a*), the air from the brake cylinder is directed to passages *a* and *b* and, if in excess of 10 pounds, the air will lift the valve *6* and pass out through the drilled hole in the brass plug *c*. When the pressure in the brake cylinder reduces to about 10 pounds, the valve will be seated by its spring, and will retain this pressure in the brake cylinder until the handle is turned down.

With the cock key turned to the high-pressure position, view (*b*), or halfway between vertical and horizontal, the air in the brake cylinder will lift valve *7* first, and will then flow through the opening in the brass choke *d* to the chamber in communication with the valve *6*. The air will next lift this valve and will escape through the plug *c* until the pressure under the valve reduces to 10 pounds when the valve will close. The valve *7* will close when the pressure in the brake cylinder reduces to 20 pounds because the pressure on the valve is then equal to a spring pressure of 10 pounds and an air pressure of 10 pounds, which is retained in chamber *e* by the valve *6*. This air pressure fills the spring chamber of valve *7* and exerts a downward pressure of 10 pounds on this valve.

With the cock handle vertical, view (*c*), the brake-cylinder air is free to discharge directly to the exhaust as shown.

75. Disorders.—The following disorders permit the escape of air from the brake cylinder and impair the efficiency of the pressure-retaining valve: A leak at the valves or cock key; a leak in the union of the retaining-valve pipe near the triple valve

or in any of the pipe joints in this pipe. If the pressure-retaining valve is to be effective, the brake cylinder must be tight, as brake-cylinder leaks will affect the usefulness of the retaining valve to the same extent as any of the disorders mentioned.

TRIPLE VALVE REPAIRS

76. Necessity for Reconditioning Valves and Valve Seats. The extent of the repairs that will be outlined will be confined to the reconditioning of the slide valve and the graduating valve and their seats. The manner in which other repairs are to be made will be found in the Maintenance of Air-Brake Equipment on Cars in the back of this lesson paper. The necessity for reconditioning valves and their seats will now be explained.

If a perfectly flat piece of metal is pressed against another flat piece and moved back and forth over it, the surfaces in contact will wear about the same amount all over. But if holes or ports are drilled in the surfaces the wear will not be uniform; more wear will occur where solid surfaces move against each other than where a solid surface moves over or partly over a port. A low spot will develop on the surface of a valve or its seat where the surfaces are always in contact; the surface will remain high where the wear is lessened by a full surface moving over a port. Owing to the arrangement of the ports, high and low spots develop on the valves and valve seats of the triple valve, preventing these parts from making intimate contact and resulting in leaks.

The work of reconditioning a valve and its seat falls under three heads, namely, filing, scraping and spotting, and grinding in, these operations being performed in the order named. Filing removes the high spots and also takes off as much more of the surfaces as will enable them to true up. Scraping removes any slight high spots that may be left after the filing operation, especially if a narrow file has been used, but if perfect filing were possible, scraping would be unnecessary. With a file especially adapted to this work, very little scraping will be required. Spotting is a test made at intervals during scraping to locate the high spots and to indicate when further scraping is unnecessary. Grinding in is the final operation and is employed to smooth off

the somewhat roughened surfaces caused by filing and scraping, and thus bring them into intimate contact.

77. Filing.—The principal work involved in the repair of triple valves is the renewal or reconditioning of the surfaces of the valves and the valve seats. The way in which this work is done will be outlined, but it is only by practice and experience that one can become proficient in doing it. The slide valve seat can be most satisfactorily renewed by using very fine parallel files made especially for this work and of the same width as the seat. Such a file may be considered as a face plate with fine cutting teeth incorporated in it. Although the ordinary types of file can be employed, yet their use requires more scraping and grinding in to recondition the parts.

Each time a seat is reconditioned it will, of course, be lower than the previous seat but the reconditioned seat should always be parallel with the original one. This condition is difficult to obtain with a file, especially as it must be passed through the bushing and can be only supported at the ends, but the filing should be done with this aim in view. The valve never travels the full length of its seat, so that there will be a high area at each end and these high points should be used as a guide, that is, each stroke of the file should be made to take approximately the same amount off each point by applying the same pressure at the ends. The file should be held flat and worked lightly and it positively must not be rocked on its seat. When the lowest point on the seat has been reached as shown by the file cutting, the filing should be discontinued and the seat tested with a face plate, especially if a narrow file has been used. If the filing has been well done, the area in contact with the face plate will be found to be considerable. With the filing well done, very little scraping will be necessary.

78. The face of the slide valve is treated in the same manner, except that the file can be placed in a vise or on a flat surface and the valve rubbed back and forth on it. The valve can be held flatter on the file than the file can be held on the valve, the result being a better seat. The graduating valve and its seat on the slide valve should be reconditioned as just explained.

79. Scraping and Spotting.—It is difficult, owing to its location, to scrape and spot the slide-valve seat. If the filing has been well done, it is possible to do a fairly satisfactory job by omitting the scraping and spotting operation and merely grinding in the valves which have been previously scraped to a good seat.

The spotting plate, if this method is used, must be accurate. Its surface is rubbed free of oil and foreign matter and polished lightly with a cloth, and a very thin smear of lampblack, red lead or other substance is applied on its surface. A thick coating must not be applied because it destroys the accuracy of the spotting plate. When rubbed on the seat, the lampblack will be transferred to the high spots on the seat, thus locating them. Hence all the surfaces that are found smudged with lampblack must be scraped down, and this is done by a fine sharp scraper that must be used in such a manner that the seat will not be gouged.

The proper progress of the work can be judged best by applying the plate at frequent intervals. With the scraping done properly, the area of the high spots that is accumulating the lampblack will be found to increase with each application of the spotting plate, thus showing that the high spots are being gradually worked down. However, the fact that a high spot disappears entirely may mean that the spot has been scraped too deep, and this will require much more work to perfect the seat. One cannot expect to be able to make a bearing over the entire seat but a good workman should be able to cover at least 75 per cent. of the area with lampblack before the spotting is discontinued, and at the same time he should be sure that there are no bad places that cannot be taken out by a small amount of grinding. The aim is not to eliminate the black on the valve seat but rather to have it spread evenly over the entire surface. This can be accomplished only by easing off the high points.

80. Grinding In.—The valves and their seats having been reconditioned, the next step is to grind them in. Valves and seats that have been well spotted in will require but little grinding; in fact, the less grinding that is done the better. The reason is that grinding is a duplication of the wear that occurs in service, and, as already pointed out, owing to the presence of the ports,

high and low spots will develop if the grinding is continued too long. In fact, the longer the grinding is continued the worse the surfaces will become, although to the eye they may look better. The aim should be to spot the valves in well and do a minimum of grinding.

81. The actual work of grinding in is done with a very fine grade of carborundum paste or, if desired, no grinding compound whatever may be employed, the surfaces being merely rubbed together with oil for finishing. The face of the valve is coated and rubbed lightly back and forth on its seat with very little pressure or with little more pressure than its own weight. The valve can be most conveniently moved by a stick. A simple test to determine the accuracy of the work is to draw lines on the face of the valve and its seat with a soft pencil and then rub the valve lightly on its seat again. If the pencil marks are now all blotted out on both the valve and its seat, the job is a good one; if not, the grinding in should be continued. A pencil mark that remains of course indicates a low spot.

It is very important that the pencil marks between two adjacent ports rub out completely, otherwise the air will leak from one port to the other. This is particularly true of the graduating-valve seat, where the two ports are close together.

82. Bushings.—When any of the bushings in the triple valve are found to be so badly worn as to require renewal, they are ordinarily sent to the manufacturer to have this work done. The work of truing piston bushings is done on a specially designed machine, made expressly for this purpose, the grinding being done by means of an emery wheel. The bushings have a comparatively long life and may last for 10 or 15 years, so that it costs less to have the manufacturer do this work, than for a railroad to incur the expense of a special machine. Hence, the bushings are ordinarily examined and rubbed with very fine emery cloth to remove any dirt or corrosion that may be found on their surfaces and to polish them so that the piston and the ring will move back and forth with the least friction. The greatest wear on the triple-piston bushing will be found between service and

service-lap positions. It requires workmanship of a high order to fit properly a piston ring to a cylinder that is worn somewhat out of round.

83. **Fitting the Ring.**—The piston packing ring provides the piston with a flexible rim which, by expanding or springing outwards against its bushing, prevents leakage from one side of the piston to the other. When a new ring is to be applied to the triple piston one should be selected of the proper width to enter the groove with little or no fitting. The ring must not be too loose; it should be capable of being moved in the groove without any side play.

After a ring of the proper width has been selected, it is compressed with the ends overlapping and inserted into the bushing in its normal position. Regardless of whether the bushing is perfectly circular or not, a new ring will not fit it all the way around because the ring was cut from stock of a slightly larger diameter than the bushing in order for it to have the required spring. The ends of the ring are now carefully filed until it will expand outwards against the bushing sufficiently for the ends to interlock.

The ring can be made to conform to the shape of the bushing, and hence made air-tight as nearly as possible, in either one of two ways. One way is to peen around the ring with a small soft-faced hammer, tapping the inner circumference lightly all the way around. This expands the ring and relieves the bushing from the excessive outward thrust of the ring at the joint. The other and longer way is to wear the ring into the bushing by placing it on a special wearing piston that permits the ring to be pulled to and fro in the bushing, which is well-oiled to prevent it from becoming scored. With both of these operations, a slight gap will finally appear between the ends of the ring but, with a bushing that is not wholly circular, this cannot be avoided.

The ring is next applied to its piston by inserting one end in the groove and then working the ring in gradually all the way around. If the ring is found to fit the groove rather tightly, a file must not be used under any circumstances. A good method is to rub the sides of the ring on fine emery cloth attached to a

perfectly flat surface, the ring being tested frequently in the groove. An old ring that is found to have a gap of $\frac{1}{16}$ inch between the ends when applied to the bushing is discarded.

LAP-JOINT PISTON PACKING RINGS

84. **Description.**—Two improvements have been made in piston packing rings for triple valves, namely, a lap joint that provides a seal at the ends of the ring under all degrees of wear, and a recess or counterbore on each side of the ring instead of the usual bevel.

Four repair sizes of the lap-joint rings are available, ranging in steps of .004 inch. The four different sizes of rings are marked diagonally across the inside surface, opposite the lap joint with one, two, three, or four parallel scratches, the number of these marks indicating the first, second, third, or fourth size of ring, respectively. With these rings any cylinder between the standard minimum and 3.512 inches in diameter can be fitted with little or no wearing in and without filing the ends of the rings. The proper size of ring to be used can be determined by the gauge, No. 37114, Fig. 4, in the A. A. R. Rules at the end of this lesson paper.

AIR LOSS FROM BRAKE-PIPE LEAKAGE

85. **Air Gauge No Indication of Loss of Air.**—The loss of air from the brake pipe by leaks is indicated by the brake-pipe hand of the air gauge, which will show a reduction of pressure. However, the reduction of pressure as shown by the gauge must not be taken as an indication of the amount of air that is lost, or of the quantity that must be supplied by the compressor to maintain the pressure. The gauges on two trains of different lengths may show an equal reduction of pressure, but it does not follow that the same amount of air is lost from each one. Therefore, the gauge alone cannot be relied upon to show the amount of air that leaks from the brake pipe.

86. **Conditions on Which Loss of Air Depends.**—The conditions that govern the amount of air that is lost from leakage can be more easily understood by considering two reservoirs, one

of which is much larger than the other. If each reservoir is supplied with the same number of cubic feet of air per minute, the pressure will increase more slowly in the large reservoir than in the small one. The reason for this is that it requires more air to increase the pressure 1 pound in the large reservoir than in the small reservoir because the air has more room to expand in the large reservoir.

It follows then that more air must leak from the larger reservoir than from the smaller reservoir in order to reduce the pressure in each an equal amount. Therefore, the loss of air from a leak depends not alone on the extent of the leak as shown by the gauge, but also on the volume of the space from which the air escapes.

87. **Rule for Loss of Air.**—The following rule may be deduced from the foregoing and will apply to the loss of air from leaks: *With the same pressure and the same rate of leakage, the loss of air from the brake pipe increases or decreases accordingly as the volume of the brake pipe is increased or decreased.*

88. **Application of Rule.**—The following examples will show the application of this rule:

1. If trains of thirty and sixty cars are charged to the same pressure and have a leakage of 5 pounds per minute, the loss of air from the longer train will be double that from the shorter, because the volume of the brake pipe of the 60-car train is double that of the 30-car train. The compressor will have to make double the number of strokes per minute to maintain the pressure on the 60-car train.

2. The gauge shows a leak of 5 pounds per minute, and all the leakage is on the engine. If the angle cock on the tender is closed and if this reduces the volume of the brake pipe to one-tenth the former volume, the gauge will show a leak of 50 pounds per minute. The compressor will have to supply the same amount of air in each case to keep the leak supplied.

3. If an engine had a brake-pipe leak of 5 pounds per minute and the brake-pipe volume were increased five times by coupling on cars that were tight, the gauge would show a leak of

1 pound per minute. However, the same amount of air will be supplied by the compressor to maintain the pressure.

89. Calculating Loss of Air From Leakage.—The amount of free air, or the volume of air at atmospheric pressure, that leaks from a train per minute after the brakes have been applied can be found by the following rule: Multiply the volume of the brake pipe, in cubic feet, by the leak, in pounds per minute, and divide by 15, the number 15 representing atmospheric pressure. The result will be the loss of air in cubic feet per minute.

EXAMPLE.—Find the leak of free air per minute with a train of 100 50-foot cars and a leak of 5 pounds per minute.

SOLUTION.—The volume of a brake pipe of a 50-foot car, including a cross-over pipe 2 ft. long and allowing 89 cu. in. for the two hose is about .493 cu. ft. By multiplying .493 by 100, the number of cars, the result will be a total brake-volume of 49.3 cu. ft. As the brakes are applied, the volume of the auxiliary reservoirs is cut off from the brake pipe by the triple valves; hence the brake-pipe volume alone is considered. Therefore the loss of air is $\frac{49.3 \times 5}{15} = 16.4$ cu. ft. Ans.

90. Effect of Brake-Pipe Leaks.—Leaks in the brake pipe increase the work performed by the compressor and increase the time required to charge and recharge the brake pipe. The leaks delay the release of the brakes, and assist the brake valve to apply them. After the brakes have been applied the leaks cause them to apply harder. As the brake pipe always leaks to a greater or less extent, the effect of brake-pipe leaks must always be taken into account when considering air-brake disorders, as the effect of disorders on brake operation may be increased or modified by such leaks.

CUBIC CONTENTS OF PIPES

91. Calculation.—The cubic contents in cubic feet in pipes of various diameters for each foot in length is given in Table I. Thus the cubic contents of a pipe 1 inch in diameter and 1 foot in length is .0055 cubic foot.

This table furnishes an easy method of calculating the cubic contents of the air-brake pipes on a car, as with the diameter known it is only necessary to multiply the length by the proper

value in the second column. The inside diameter of the main brake pipe is 1¼ inches, and the diameter of the cross-over pipe is 1 inch. An air hose has a diameter of 1⅜ inches, a length of 22 inches, and a volume of 44.5 cubic inches.

TABLE I

CUBIC CONTENTS OF PIPES

Diameter in Inches	Cubic Contents, in Cubic Feet, for Each Foot in Length	Diameter in Inches	Cubic Contents, in Cubic Feet, for Each Foot in Length
1	.0055	2	.0218
1¼	.0085	2¼	.0276
1⅜	.0103	2½	.0341
1½	.0123	3	.0491
1¾	.0168		

92. **Volume of Free Air.**—In the second column of Table II is shown the volume of free air by which is meant the volume at atmospheric pressure for each cubic foot of air at the pressure given in the first column. Thus, at a gauge pressure of 50

TABLE II

VOLUME OF AIR WHEN EXPANDED AND COMPRESSED

Gauge Pressure Pounds	Volume of Free Air for One Cubic Foot of Air at Given Pressure	Gauge Pressure Pounds	Volume of Free Air for One Cubic Foot of Air at Given Pressure
10	1.68	70	5.762
15	2.02	75	6.102
20	2.36	80	6.442
25	2.7	85	6.782
30	3.04	90	7.122
35	3.38	95	7.462
40	3.72	100	7.802
45	4.06	110	8.483
50	4.40	120	9.170
55	4.74	130	9.843
60	5.08	140	10.52
65	5.42	150	11.20

pounds, one cubic foot of air when expanded to the pressure of the atmosphere would occupy a space of 4.40 cubic feet.

The number of cubic feet of free air in the brake pipe can be readily calculated from Tables I and II. For example, let it be assumed that the brake pipe is 2,500 feet in length. From Table I the cubic contents is $2{,}500 \times .0085$, or 21.25 cubic feet. If the pressure is assumed to be 70 lb., the volume of free air in the brake pipe will be 21.25×5.762, or 122.4 cubic feet.

MAXIMUM NUMBER OF CUT-OUT BRAKES

93. Before a train can leave a terminal all brakes must be in operative condition, and the train cannot be moved if, when

TABLE III
PERMISSIBLE NUMBER OF CUT-OUT BRAKES

Number of Cars in Train	Maximum Number of Cars Allowed Without Operative Air Brakes
6 cars or less	0
7 cars to 13 cars, inclusive	1
14 cars to 19 cars, inclusive	2
20 cars to 26 cars, inclusive	3
27 cars to 33 cars, inclusive	4
34 cars to 39 cars, inclusive	5
40 cars to 46 cars, inclusive	6
47 cars to 53 cars, inclusive	7
54 cars to 59 cars, inclusive	8
60 cars to 66 cars, inclusive	9
67 cars to 73 cars, inclusive	10
74 cars to 79 cars, inclusive	11
80 cars to 86 cars, inclusive	12
87 cars to 93 cars, inclusive	13
94 cars to 99 cars, inclusive	14
100 cars to 106 cars, inclusive	15
107 cars to 113 cars, inclusive	16
114 cars to 119 cars, inclusive	17
120 cars to 126 cars, inclusive	18
127 cars to 133 cars, inclusive	19
134 cars to 139 cars, inclusive	20
140 cars to 146 cars, inclusive	21
147 cars to 153 cars, inclusive	22

in route, more than 15 per cent of the brakes are cut out. Table III is given for convenience in quickly determining the maximum number of cut-out brakes with which a train may be permitted to proceed when in route if it is impossible to have repairs made. If one of two sets of brakes on a car are cut out on account of defects, it is to be counted as a cut-out brake.

MAINTENANCE OF AIR-BRAKE EQUIPMENT

Adopted as Standard 1925

Revised 1933 and 1934

These rules were formulated jointly by the Bureau of Safety of the Interstate Commerce Commission and the Safety Appliance Committee, of the Mechanical Division of the American Railway Association. They represent minimum requirements, and shall govern the maintenance of air brake equipment on cars, provided that nothing herein contained shall be construed as prohibiting carriers from enforcing additional rules and instructions not inconsistent with these rules.

Terminal Train Brake Tests

20. Foremen of inspectors and inspectors are jointly responsible for the condition of the air brake and train air signal equipment on cars leaving their station.

21. The train signal system on passenger carrying trains shall be tested and known to be in suitable condition for service.

22. (a) Each train must have the air brakes on all cars in effective operating condition, except in case of emergency, but at no time shall the number of operative air brakes be less than permitted by Federal requirements.

(b) Terminal tests of the train brake system must be made as prescribed in rules 23 to 32, inclusive, on each railroad at originating terminals and other points where necessary to insure that the condition of the brakes is in accordance with the requirements of rule 22 (a).

23. Condensation must be blown from the pipe from which air is taken before connecting yard line or engine to train.

24. The train must be charged to required pressure, retaining valves, and retaining valve pipes on freight cars inspected and known to be in suitable condition for service, and the position of angle cocks, cut-out cocks and hose noted. A careful examination must be made for leaks and necessary repairs made to reduce leakage to a minimum.

25. (a) After the brake system on a freight train is charged to not less than 5 lb. below the standard pressure for that train, and on a passenger train when charged to at least 70 lb., a fifteen pound service reduction must be made upon request or proper signal, then note the number of

pounds of brake pipe leakage per minute as indicated by the brake pipe gauge, after which the reduction must be increased to a total of twenty pounds. Then an examination of the train brakes must be made to determine if brakes are applied in service application on each car; that the piston travel is correct, and that brake rigging does not bind or foul.

(b) When the examination has been completed in accordance with rule 25 (a) proper release signal must be given and each brake examined to see that it releases properly.

26. Brake pipe leakage must be reduced to the minimum but must not exceed 7 pounds per minute.

27. Piston travel less than seven inches or more than nine inches, must be adjusted to nominally eight inches.

28. When the test is completed the inspector or trainman who made the test will personally inform the engineman and conductor, and advise them the number of cars in train and the number having inoperative brakes.

29. Defects discovered during a standing test that cannot be repaired promptly must be reported to the foreman inspector or conductor for appropriate action in accordance with instructions of the individual carrier.

30. During standing tests brakes must not be applied or released until proper signal is given.

31. (a) When a train is tested from a yard test plant, an engineer's brake valve, or a suitable testing device which provides for the increase and reduction of brake pipe pressure at the same or a slower rate as witn the engineer's brake valve, should be used and be connected to the same point in the train to which the engine is to be attached.

(b) The train should be charged and tested as prescribed in rules 23 to 28, incl., and where practical should be kept charged until the road locomotive is coupled to train, when an application and release test should be made as prescribed in rule 40 for passenger trains and rule 41 for freight trains.

(c) If brake valve or testing device specified in rule 31 (a) is not used, or if after testing the brakes from a yard plant as prescribed in rule 31 (b) the train is not kept charged until road locomotive is coupled on, the brakes must be tested as prescribed in rule 42.

32. Before adjusting piston travel or working on brake rigging, cut-out cock in branch pipe must be closed, and reservoirs bled. Where cut-out cock is in cylinder pipe the latter only need be closed.

Road Train Brake Tests

40. On a passenger train, before an engine is changed or an angle cock closed, except for cutting off one or more cars from the rear of train, the brake must be applied. After recoupling and opening the angle cock and before proceeding, an application and release test must be made

from the engine. Inspector or trainmen will note that the rear brakes of train apply and then signal for a release, noting that rear brakes release.

41. On a freight train, before an engine is detached or an angle cock closed on an engine or a car, the brake must be fully applied. After recoupling and opening the angle cock and before proceeding, it must be known that the brake pipe pressure is being restored as indicated by the caboose gauge and that the rear brakes are released. In the absence of a caboose gauge, a test must be made as prescribed in rule 40.

42. At point where motive power or engine crew or train crew is changed, tests of the train brake system must be made as follows:

After the brake system on a freight train is charged to not less than 5 lb. below the standard pressure for that train, as indicated by the locomotive gage, and on a passenger train to at least 70 lb., a fifteen pound service reduction must be made upon proper request or signal, brake pipe leakage noted as indicated by the brake pipe gage (which must not exceed 7 lb. per minute), after which the reduction must be increased to 20 lb. Then an examination of the train brakes must be made to determine if brakes are applied in service application on each car. When this examination has been completed, proper release signal must be given and each brake examined to see that it releases properly.

43. When one or more cars are added to a train at any point subsequent to a terminal test the cars added, when in the position where they are to be hauled in the train, must be tested as prescribed in rule 42. Before proceeding, it must be known that the brake pipe pressure is being restored as indicated by the caboose gauge and that the rear brakes are released. In the absence of a caboose gauge, a test must be made as prescribed in rule 40.

44. Before a train is operated down a grade requiring the use of retaining valves, it must be known that they are in such condition that the speed of the train can be safely controlled by the engineman.

45. Whenever the locomotive is to be detached or a stop made on a heavy grade under circumstances in which the efficiency of the air brake system may be impaired by allowing the train to stand with the brakes applied, a sufficient number of hand brakes must be set to hold the train before the air brakes are released or the engine cut off. When ready to start, hand brakes must not be released until it is known that the air brake system has been fully recharged.

Air Brake Tests of Arriving Trains

46. Where inspectors are employed to make a general inspection of cars upon arrival at a terminal they must make a visual inspection of retaining valves, release valves and rods, retaining valve pipes, brake rigging, hand brakes, hose and position of angle cocks, and make necessary repairs or mark for repair tracks any cars to which yard repairs cannot be made promptly.

47. Freight trains arriving at terminals where facilities are available and at which special instructions provide for immediate brake inspection and repairs, shall be left with air brakes fully applied. Inspection of brakes and needed repairs must be made as soon thereafter as practicable.

Double Heading and Helper Engines

50. When more than one engine is used, brakes must be operated from the leading engine, automatic brake valves on all except the leading engine cut out, handles of brake valves kept in running position, and when practicable air compressors kept running.

Running Tests

51. On a passenger train, after engine or engine crew has been changed or an angle cock closed, except for cutting off cars from rear, a running test of brakes must be made as soon as speed of train permits. Such test should be made by applying the train brakes with sufficient force to ascertain whether they are operating properly. Steam or power should not be shut off unless conditions require it. In case the brakes do not operate properly in this test, the signal for brakes must be given.

FREIGHT AND PASSENGER TRAIN—CAR BRAKES MAINTENANCE OF

Brakes on Cars on Shop or Repair Track With Stencils "In Date"—Tests and Repairs

100. When freight cars are on shop or repair tracks where facilities are available for making air brake repairs, and the stencil date is twelve months old or over (except for complete AB type freight brake equipment using the AB type brake cylinder, where the stencil date is thirty-three months old or over), the brake equipment should be given the attention specified for cars requiring periodical repairs.

101. Cars on shop and repair tracks with stencil dates less than limits specified in Rule 100, should be connected to an air plant equipped with testing apparatus and a dummy coupling attached to hose on the opposite end of car. The pipe, including angle cocks, cut-out cock and hose, should be tested under a pressure of not less than 70 pounds, using soap-suds for this test when weather conditions permit. All leakage should be reduced to a minimum. Any hose found porous or leaking around the fittings, or otherwise defective, and any cocks found leaking at top of key should be removed. Brake pipe must be securely clamped, angle cocks in their proper position with suitable clearance, reservoirs and cylinders tight on their supports and the latter securely attached to car, and piston travel adjusted to from 7 in. to 9 in.

102. The brake cylinder must be tested for leakage with a gage attached to the retaining valve exhaust or triple valve exhaust port,

and the triple valve tested with a specified testing device to determine whether it will apply and release properly in both service and emergency applications. If the triple valve fails to pass this test or the brake cylinder leakage exceeds 8 pounds per minute, the entire brake equipment must be given the attention specified for cars requiring periodical repairs when stencil is out of date. If triple valve and brake cylinder pass the prescribed test, the retaining valve and its pipe connections must be tested by applying the brake with a 20 pounds reduction from not less than 70 pounds brake pipe pressure and when the triple valve is released the retaining valve must hold the brake applied for a period of not less than three minutes.

103. The hand brake and connections must be inspected, tested and necessary repairs made to insure that it is in suitable condition for safe and effective operation when the car is in motion.

Air Brakes on Cars—Periodic Repairs

110. The air brake equipment on cars must receive the inspection and repairs prescribed in Rules 112 to 169, inclusive, as often as required to maintain it in suitable condition for service, but not less frequently than once in fifteen months (except for complete AB type freight brake equipment using the AB type brake cylinder, on which the time limit is thirty-six months).

Cleaning, Lubricating and Testing Brake Cylinders

112. First, the piston rod must be secured to the non-pressure cylinder head, then after removing the non-pressure head, piston rod, piston head and release spring, scrape off all deposits of gum and dirt, and thoroughly clean the removed parts. Oil must not be used for cleaning leather packing.

113. Thoroughly clean the brake cylinder, including non-pressure head joint, by first using a dull rounded scraper for removal of the heavy grease and dirt, wiping dry with rags or waste. Use no oil unless the substance in the cylinder cannot be removed without softening. Rust spots inside of cylinder are to be removed.

114. Particular attention must be paid to cleaning the leakage groove and the auxiliary tube. Triple valve or pipe connections must be removed when the auxiliary tube is being cleaned.

115. Expander ring, when used, should be a true circle when applied to the packing and fit the entire circumference, having an opening of from $\frac{3}{16}$ in. to $\frac{1}{4}$ in. Expander rings are not to be used in composition cylinder piston packing.

116. A packing which is badly worn must be replaced with a new one. If the packing is slightly worn on one side, but otherwise in good condition, it should be turned so as to bring the worn side away from the bottom of the cylinder. The packing must be placed centrally on the

piston head, with the flesh side of leather packing next to cylinder. Follower studs must be tight in piston head, and nuts drawn up uniformly tight.

117. The inner wall of the cylinder and the bearing surface of the packing must be lightly coated with a suitable lubricant.

118. No sharp tools should be used in entering the piston packing into the cylinder.

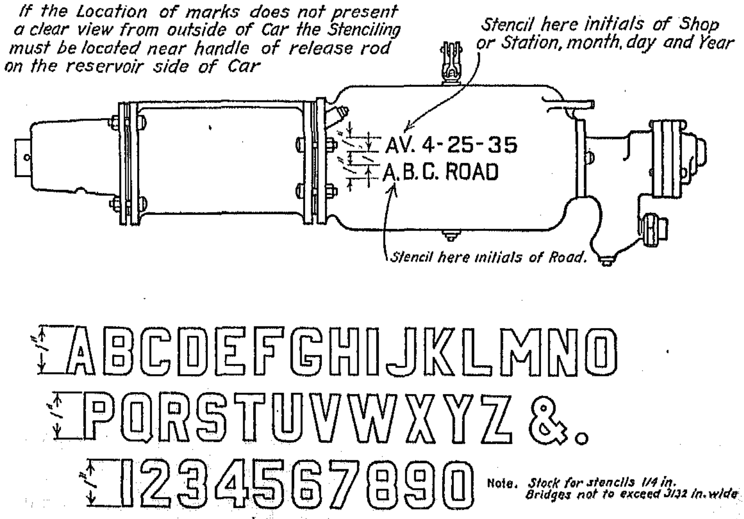


Fig. 1

119. After the piston is entered in the cylinder, and before cylinder head is replaced, the piston rod should be slightly rotated in all directions, about 3 in. from the center, to be certain that the piston does not bind.

120. All old cleaning marks must be scraped off and painted over with quick drying black paint. The place, month, day and year of cleaning and the initials of road, must be stenciled with white paint on the auxiliary reservoir as shown in Figure 1 or Figure 2 or if this location does not present a clear view from the outside of car, the stenciling should be located near handle of release rod on the reservoir side of car. On tank cars having but two longitudinal sills, this stenciling may be located on reservoir side of center sill at center of car.

121. For passenger train cars, the stenciling must be in suitable location for visual inspection in accordance with instructions on individual roads.

122. The bolts and nuts holding the cylinder and reservoir to their supports and the latter to the car, must be securely tightened, using

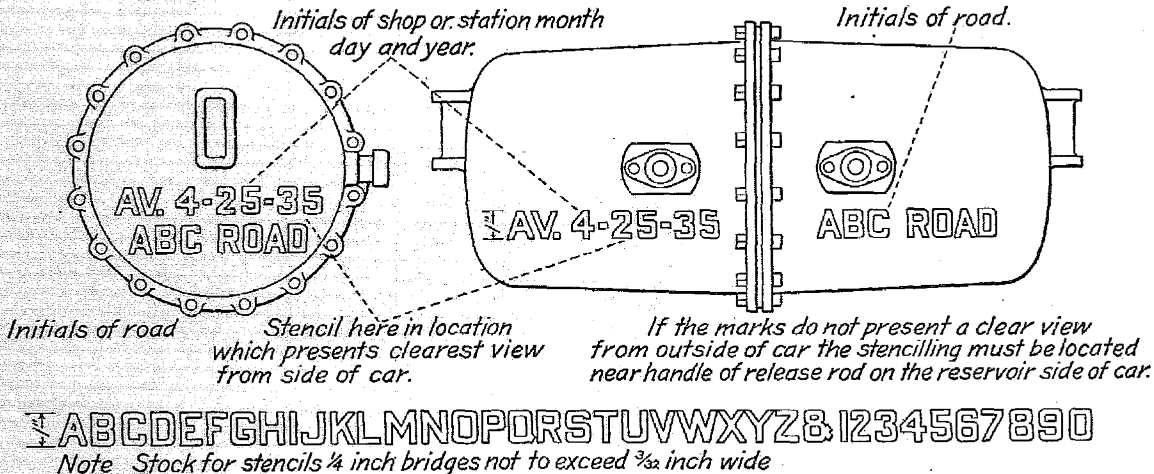

Initials of shop or station month day and year.
Initials of road.
O
AV. 4-25-35
ABC ROAD
AV. 4-25-35
ABC ROAD
Initials of road
Stencil here in location which presents clearest view from side of car.
If the marks do not present a clear view from outside of car the stencilling must be located near handle of release rod on the reservoir side of car.
ABCDEFGHIJKLMNOPQRSTUVWXYZ& 1234567890
Note Stock for stencils ¼ inch bridges not to exceed 3/32 inch wide

Fig. 2

washers between bolting flanges and supports where necessary to avoid strain in brake cylinder when supporting bolts are tightened.

123. After cleaning the brake cylinder it must be tested for leakage with a gage attached to the exhaust port of the triple valve control valve, vent port in brake cylinder cut-out cock or to the retaining valve exhaust port.

124. This test must be made with an initial brake cylinder pressure of not less than 50 pounds, piston travel adjusted to nominally 8 inches, except when slack adjusters are used the piston travel must be such as to admit pressure to the slack adjuster cylinder. Brake cylinder leakage must not exceed 5 pounds per minute with triple or control valve in release position.

Cleaning, Lubricating and Testing Triple Valve

130. The triple valve must be removed from the car for cleaning and replaced by one in good condition. It must be dismantled, the retarded release parts removed from the body and all internal parts, except those with rubber seats and gaskets, cleaned with gasoline or a turpentine substitute, preferably the former, then blown off with compressed air and wiped dry with a cloth.

131. No hard metal should be used to remove gum or dirt or to loosen the piston packing ring in the groove.

132. The feed groove should be cleaned with a piece of wood, pointed similar to a lead pencil. Rags or cloth must be used for cleaning purposes as waste leaves lint on the parts on which it is used.

133. In removing the emergency-valve brass seat, care must be exercised not to bruise or distort it.

134. The triple-piston packing ring must have a neat fit in its groove, and also in the triple-piston bushing. Once removed from the piston, or distorted in any manner, it must be condemned.

135. The graduating stem must work freely in the guide nut. The graduating spring and the retarded release spring in the retarded release triple valves must conform to standard requirements and be free from corrosion. The threaded portion of the graduating-stem guide must be coated with oil and graphite or graphite grease before reapplying it to the triple valve cap.

136. The emergency-valve rubber seat must be renewed unless it can plainly be seen to be in first-class condition. A check-valve case having a cast-iron check-valve seat must be replaced with a case having a brass seat.

137. The cylinder-cap gasket and the check-valve case must be carefully examined and cleaned with a cloth but not scraped; those not in good condition must be replaced.

138. Standard gaskets as furnished by the air-brake manufacturers must be used. Gaskets of irregular thickness result in leakage, bending or breaking piston stems and improper registering of triple valve ports.

139. The tension of slide-valve spring should be regulated so that the outer end is $\frac{1}{8}$ in. higher than the bore of the bushing when entering the spring.

140. Before assembling the parts after cleaning, the castings and the ports in the body of the triple valve must be thoroughly blown out with compressed air, and all parts of the triple valve not elsewhere provided for, known to be in good condition.

141. Polish the seat and face of the slide valve and slide-valve graduating valve with high-grade, very fine, dry graphite, by rubbing it into the surface and the upper portion of the bushing where the slide-valve spring bears, using a flat pointed stick over the end of which a piece of chamois skin has been glued, leaving no loose graphite on the seat. The chamois skin can be dispensed with provided the stick is made of soft wood. The parts to be polished with graphite must be free from oil or grease.

142. The triple-valve piston-packing ring and its cylinder must be lubricated with a light anti-friction oil as follows: Insert the piston and its valve *in the body*, leaving them in release position, then lubricate the piston cylinder sparingly and move the piston back and forth several times, after which remove the surplus oil from the outer edge of the cylinder. No lubricant should be applied to the emergency or check valves.

143. All triple valves after being cleaned or repaired must be tested on an A. A. R. standard test rack and pass the prescribed test before being placed in service. "K" triple valves must also be tested for feed groove location.

144. At points where repairs to triple valves are made, involving items (a) to (h) inclusive, such triple valves must be dismantled and all parts for which A. A. R. gages are provided must be checked for wear, with gages specified below. *Parts which do not conform to specified* dimensions of these gages must be replaced with parts known to be within said gage limit.

(a) Main piston bushing.
(b) Main piston.
(e) Graduating valve.
(g) Emergency piston.
(c) Main piston ring.
(d) Slide valve.
(f) Emergency piston bushing.
(h) Emergency valve brass seat.

Gage No. 36958 for gaging outside diameter of emergency piston.
Gage No. 36952 for gaging diameter emergency piston bushing.
Gage No. 36954 for gaging diameter main piston.
Gage No. 36960 for gaging depth of check valve in check case bush.
Gage No. 36957 for gaging thickness of graduating valve.

Gage No. 36961 for gaging thickness of flange and height of beaded seat on emergency valve seat.

Gage No. 36962 for gaging guide hole in emergency valve seat.

Gage No. 37021 for gaging thickness of slide valve and depth of exhaust cavity K-2.

Gage No. 36963 for gaging height of graduating stem above gasket face.

Gage No. 37114 for gaging piston bushing diameter and ring size.

Gage No. 86894—alternate—ring size.

Gage No. 36964 for gaging retarding device stem.

Gage No. 36956 for gaging thickness of slide valve and depth of exhaust cavity K-1.

Use of gages for gaging parts of triple valves specified above is not required at points where triple valves are cleaned but no repairs to triple valves are made.

145. Should any of the triple valve bushings require renewing, such work must be done by the air-brake manufacturers.

146. When applying the triple valve to the auxiliary reservoir, the gasket should be placed on the triple valve, not the reservoir.

Control Valves

150. All portions of control valves must be removed from the car for cleaning and lubricating, as specified for triple valves, and tested on a standard test rack.

Miscellaneous Inspection and Repairs

160. When brake cylinders and triple valves are cleaned, the following additional work must be performed:

161. The automatic slack adjuster cylinder and the high speed reducing valve must be cleaned each time the brake cylinder is cleaned. The cylinder and packing leather must be lubricated with the same kind of lubricant and in the same manner as brake cylinders. The large adjuster screw must be wiped dry and a small quantity of dry graphite put in the hollow of adjuster nut.

162. The brake pipe and branch pipe must be thoroughly blown out and the triple valve or branch pipe strainer cleaned before recoupling the branch pipe. If a dirt collector is used, the plug must be removed, the dirt collector thoroughly cleaned and the threaded portion of the plug or flange bolts coated with oil and graphite or graphite grease before replacing.

163. Retaining valve must be cleaned by removing the cap; wiping or blowing out all dirt, seeing that valve and its seat are in good condition, the retaining position exhaust port open and that the valve is well secured to the car in a vertical position.

164. The retaining valve and its pipe must be tested, preferably with an air gauge attached to the retaining valve pipe or to the exhaust port if the construction of the retaining valve permits, by applying the brake

with a 20 lb. reduction from not less than 70 lb. brake pipe pressure, and when the triple valve assumes release position the combined leakage from the cylinder, retaining valve and retaining valve pipe must not be greater than specified in the following table.

Type of Retaining Valve	Position of Handle	Initial Cylinder Pressure	Combined leakage from the cylinder, retaining valve and pipe must not exceed that shown below. Number Pounds Leakage per Minute
15 lb. Single Pressure Spring and Weighted Type	....	10 lb.	5
10-20 lb. Double Pressure Spring Type	High	15 lb.	6
	Low	7 lb.	3
15-30 lb. Double Pressure Weighted Type..	....	20 lb.	6
15-30 Double Pressure Spring Type	High	20 lb.	6
	Low	10 lb.	5
25-50 lb. Double Pressure Weighted Type..	....	40 lb.	8
25-50 lb. Double Pressure Spring Type	High	40 lb.	8
	Low	15 lb.	6

165. If the retaining valve and its pipe are not tested with a gage, as prescribed in rule 164, it must be tested by applying the brake with a 20 lb. reduction from not less than 70 lb. brake pipe pressure and when the triple valve is released the retaining valve must hold the brake applied with force for 3 minutes at the end of which time the air must discharge at the retaining valve exhaust.

166. Pipe joints, hose, release valve, angle and cut-out cocks must be tested under a pressure of not less than 70 lb., using soapsuds for this test when weather conditions permit.

167. Pipe clamps must be applied where missing and tightened where loose; hose and angle cocks in their proper position, and if the piston travel is less than 7 or more than 9 inches it must be adjusted to nominally 8 inches.

168. The hand brake and connections must be inspected, tested, and necessary repairs made to insure that it is in suitable condition for safe and effective operation when the car is in motion.

169. Stencil dates for freight cars must not be changed unless rules 112 to 168, inclusive (except rule 121), have been complied with.

INSTRUCTIONS FOR USE OF CONDEMNING GAGES FOR TYPE "K" TRIPLE VALVES

Piston Diameter Caliper Gage—No. 36954

If main piston diameter is worn sufficiently that the calipers can be passed over it, the piston should be replaced.

Diameter of Emergency Piston Bush Caliper Gage—No. 36952

If emergency piston bushing is worn sufficiently to allow gage to enter at any point the bushing should be condemned.

Diameter of Piston Bushing Cylinder Gage—No. 37114

For checking piston bushing diameter. In applying gage to cylinder, hold gage at the ribs and insert with a rotating motion. The square dial must be in the position so that the figure 1 is nearest outer rim of gage. After the gage is inserted the dial should be rotated clock-wise with the finger until it comes in contact with cylinder wall. Do not use pressure. If mark "COND" clears cylinder, the cylinder bushing must be condemned. This gage also identifies proper size ring to be used when necessary to apply new ring as follows: If Mark 2 does not clear cylinder, No. 1 ring is required. If Mark 2 clears and 3 does not clear cylinder, No. 2 ring is required. If Mark 3 clears and 4 does not clear cylinder, No. 3 ring is required. If Mark 4 clears and Mark "COND" does not clear cylinder, No. 4 ring is required. If gage will not enter cylinder, use No. 1 ring.

Depth of Seat in Check Case—Flat Gage—No. 36960

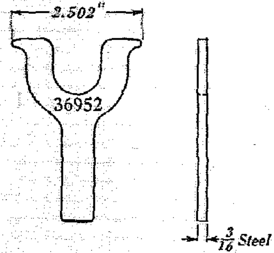
For checking depth of seat in check case bushing. If wear has increased the depth of the seat or valve to the extent that the gage face contacts the face of check case, the bushing should be condemned.

Emergency Valve Seat—Flat Gage—No. 36961

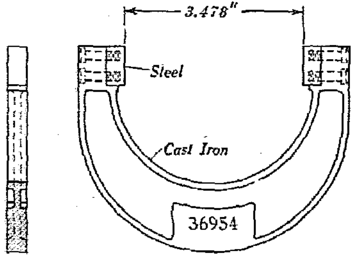
For checking thickness of flange and height of beaded seat on emergency valve seat. If flange is worn down sufficiently to allow it to enter slot in gage, the seat should be replaced. The projection on the side of this gage should be laid across the emergency valve seat. If the seat is worn below the level of the flanges, to the extent that the gage makes contact on the flange, that is, if no light can be seen between the flange and the gage, the seat should be replaced.

Emergency Valve Seat—Diameter of Guide Hole—Caliper Gage No. 36962

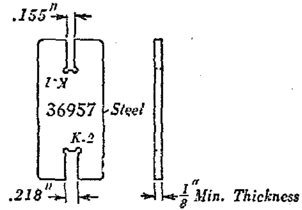
For checking guide hole in emergency valve seat. If guide hole is worn large enough to allow caliper to enter at any point the seat should be replaced.



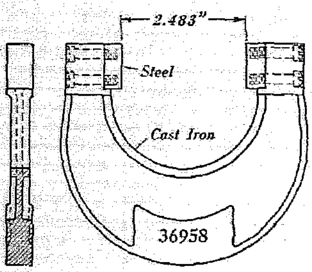
Gage for checking diameter of emergency piston bush.



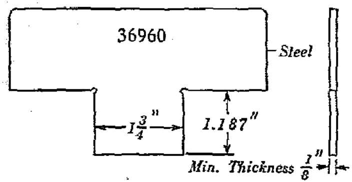
Gage for checking piston diameter



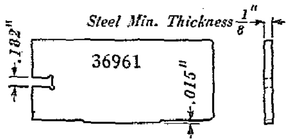
Gage for checking thickness of graduating valve



Gage for checking outside diameter of emergency piston.



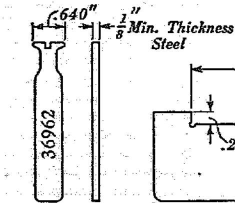
Gage for checking depth of check valve in check case bush.



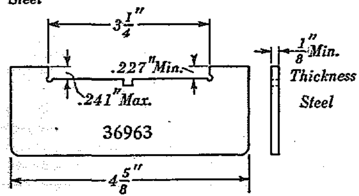
Gage for checking thickness of flange and height of beaded seat on emergency valve seat

Note: Any form of gage may be used which provides for gaging parts in accordance with triple valve wear-limit gage dimensions. Gages will be furnished by Air Brake Manufacturers in accordance with gage No. shown on various gages.

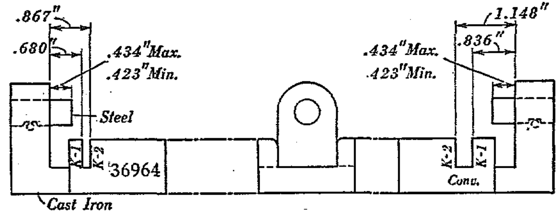
TRIPLE VALVE WEAR LIMIT GAGES
FIG. 3



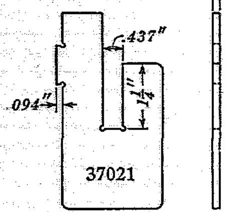
Gage for checking guide hole in emergency valve seat.



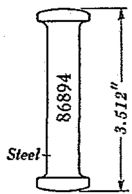
Gage for checking height of graduating stem above gasket face.



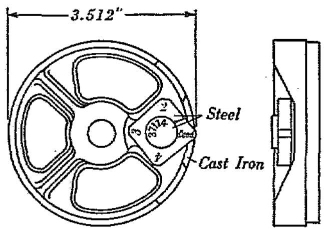
Gage for checking retarding device stem



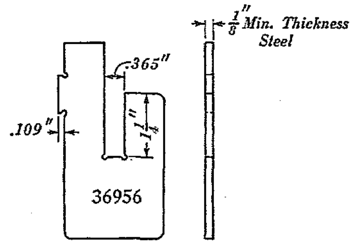
Gage for checking thickness of slide valve and depth of exhaust cavity.



Alternate for Condemning Bushings



Gage for checking piston bush diameter (Preferred)



Gage for checking thickness of slide valve and depth of exhaust cavity.

Note: Any form of gage may be used which provides for gaging parts in accordance with triple valve wear-limit gage dimensions. Gages will be furnished by Air Brake Manufacturers in accordance with gage No. shown on various gages.

TRIPLE VALVE WEAR LIMIT GAGES
FIG. 4

Emergency Piston—Outside Diameter of Piston—Caliper Gage No. 36958

For checking outside diameter of emergency pistons. If the piston is worn to the extent that the caliper passes over the diameter at any point, the piston should be replaced.

Slide Valve and Graduating Valve—Flat Gage—No. 36956 Flat Gage for K-2 Triple Valves—No. 37021

For checking thickness of slide valve and depth of exhaust cavity. If thickness of slide valve is reduced to the extent that the slide valve will enter the gage slot, or when the projection on side of gage is inserted in exhaust cavity, if depth of cavity is less than the projection, that is, if the gage does not set flat on the seat, the valve should be replaced.

Thickness of Graduating Valve—Flat Gage—No. 36957

For checking thickness of graduating valve. If K-1 graduating valve will enter the small slot, it should be replaced. If K-2 graduating valve will enter the large slot, it should be replaced.

Assembled Cylinder Caps—Height of Graduating Stem Above Gasket Face—Flat Gage—No. 36963

For checking height of graduating stem above gasket face. This gage has a maximum side and a minimum side separated by the notch and marked accordingly. If the stem extends above the gasket face far enough to prevent the maximum side of gage passing freely across the face, that is, if the maximum side does not clear the stem and allow the two legs to rest flat on the face, the stem is too long and should be reduced in length sufficiently to pass the gage. If the stem does not extend above the gasket face far enough to prevent the minimum side of the gage from passing freely across the face, that is, if the minimum side does not prevent the two gage legs from setting flat on the gasket face, the stem is too short. Thoroughly clean the seat in cap or collar on graduating stem and if stem is still too short replace stem or cap as required.

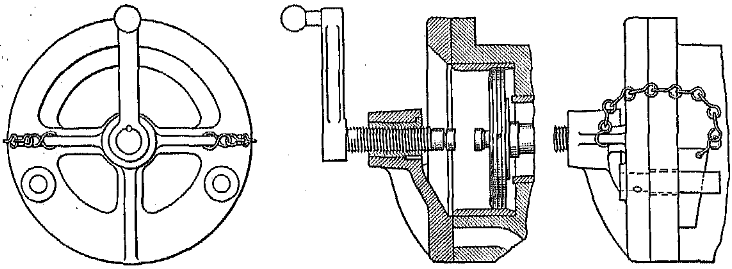
Retarding Stem—Gage—No. 36964

For checking retarding device stems of K-1, K-2, K-1-C, and K-2-C triple valves. This gage consists of a V block which holds the retarding stem. There are slots on either side, which are stencilled for the different type valves and a movable stem through the upright part of device. Retarding device should be held in V block with flat portion of device firmly against upright part of gage. The stem in gage should be forced against the center stem of the retarding device piston; the long shoulder or upper half of the stem should not extend into the device beyond flush, and the short part or lower half of the stem should not extend outward beyond flush. Edge of cylinder portion of retarding device piston of K-2

and K-2 converted valves should be in sight through their slots; edge of K-1 and K-1 converted type should not be visible in slots; retarding device piston should be replaced if it fails in any of these tests.

Feed Groove Location Device—Gage No. 92915

For checking opening of feed groove in relation to exhaust port. This test is made on the 3-T test rack. With the triple valve assembled on the rack, remove cylinder cover and replace with the gage. Turn handle screw of the device outward (counter clock-wise) until the triple valve piston can be moved to application position. Place handle of valve "R" in position No. 5, charging the auxiliary reservoir and brake cylinders to ten pounds. Return valve "R" handle to position No. 2. Turn handle screw inward (clock-wise) and note the brake cylinder and auxiliary



reservoir gages. If the brake cylinder pressure starts to drop before or at same time auxiliary reservoir reduces, the triple valve is correct. If the auxiliary reservoir pressure starts to reduce ahead of brake cylinder pressure, the feed groove is too long, or the release port is improperly located with relation to the piston and slide valve assembly. If in doubt as to the proper position of the feed groove—this may be determined in the following manner: First coat the brake cylinder exhaust opening with soap suds and then place a finger on the triple piston at the point where the feed groove is located, so any air escaping through the feed groove will strike the finger and in this way be detected. If air is noted at the finger before a bubble at the exhaust opening shows that brake cylinder pressure is starting to escape, this will indicate that the feed groove is too long or the release port is not properly located.

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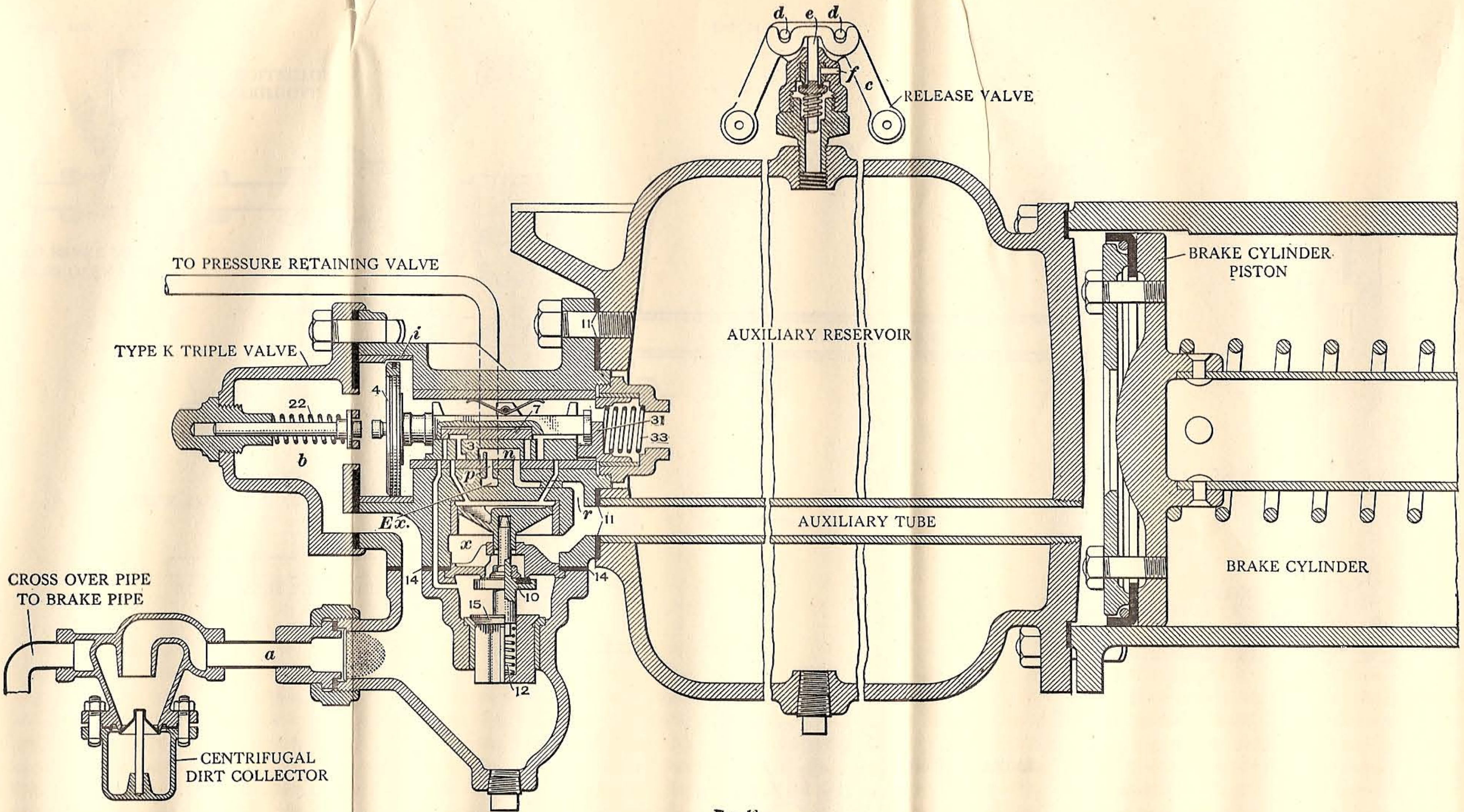

Fig. 13

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92888

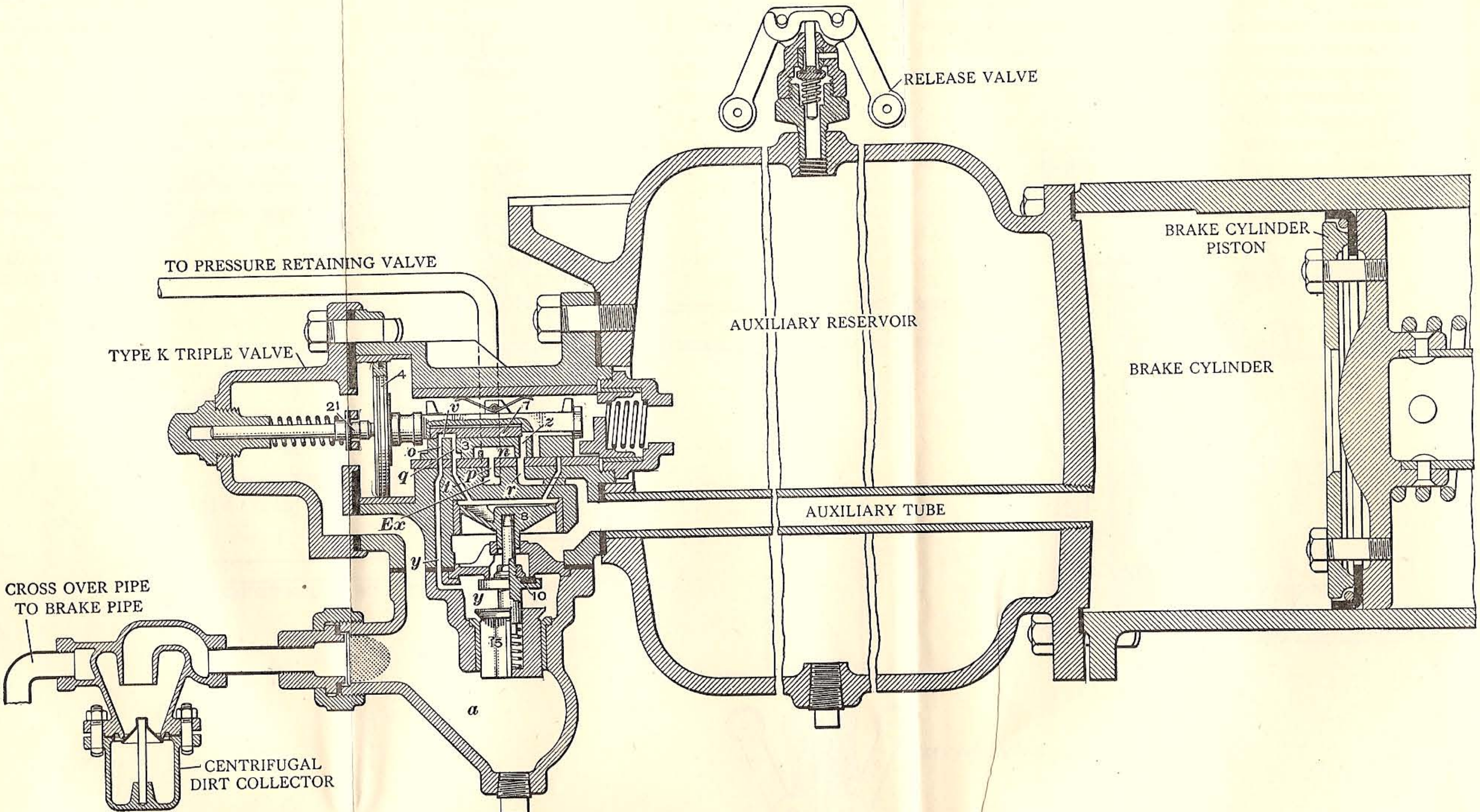

Fig. 14

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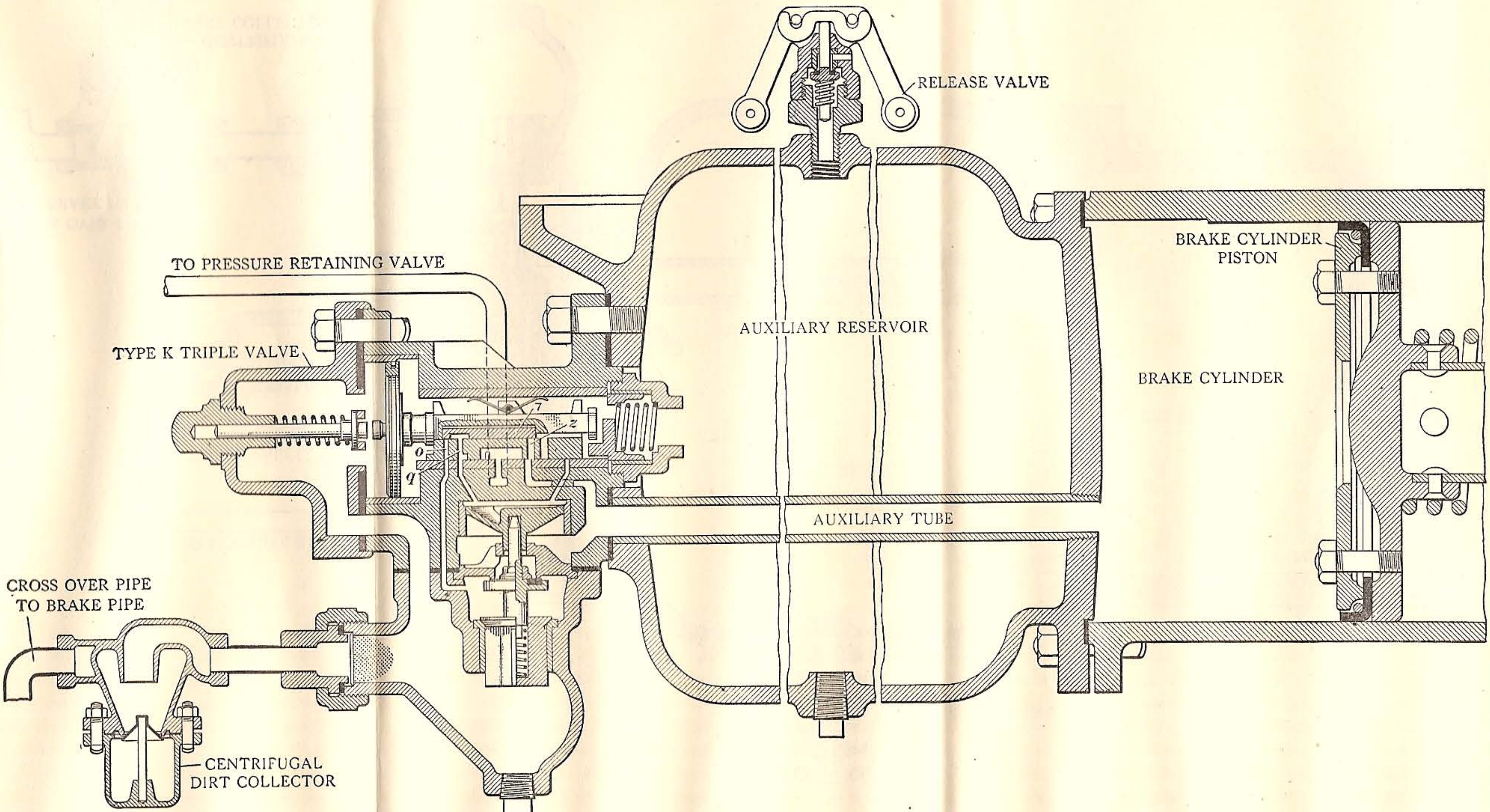

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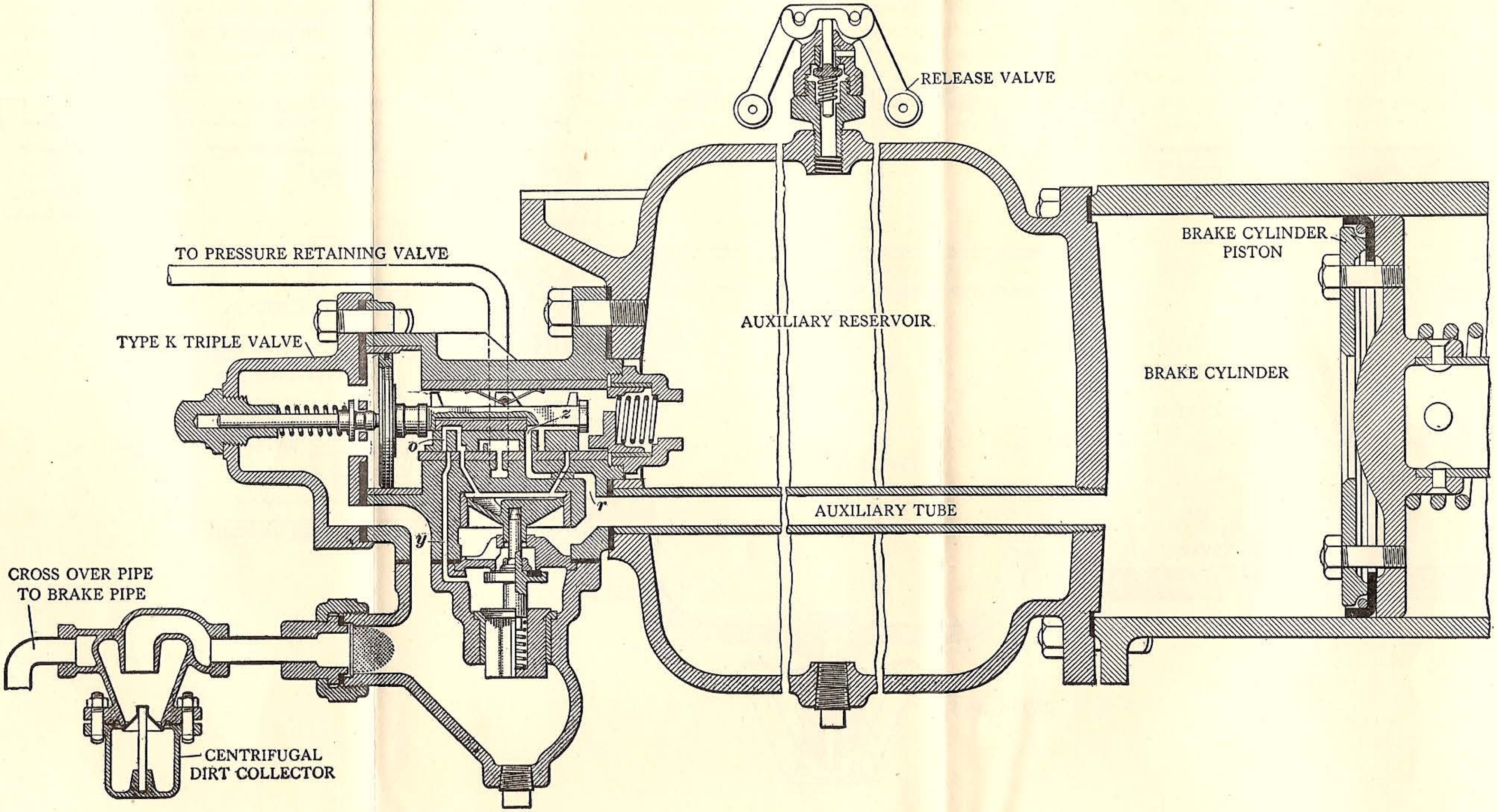
Fig. 15



RELEASE VALVE
TO PRESSURE RETAINING VALVE
TYPE K TRIPLE VALVE
AUXILIARY RESERVOIR
BRAKE CYLINDER PISTON
BRAKE CYLINDER
z
o
r
y
AUXILIARY TUBE
CROSS OVER PIPE TO BRAKE PIPE
CENTRIFUGAL DIRT COLLECTOR

FIG. 16

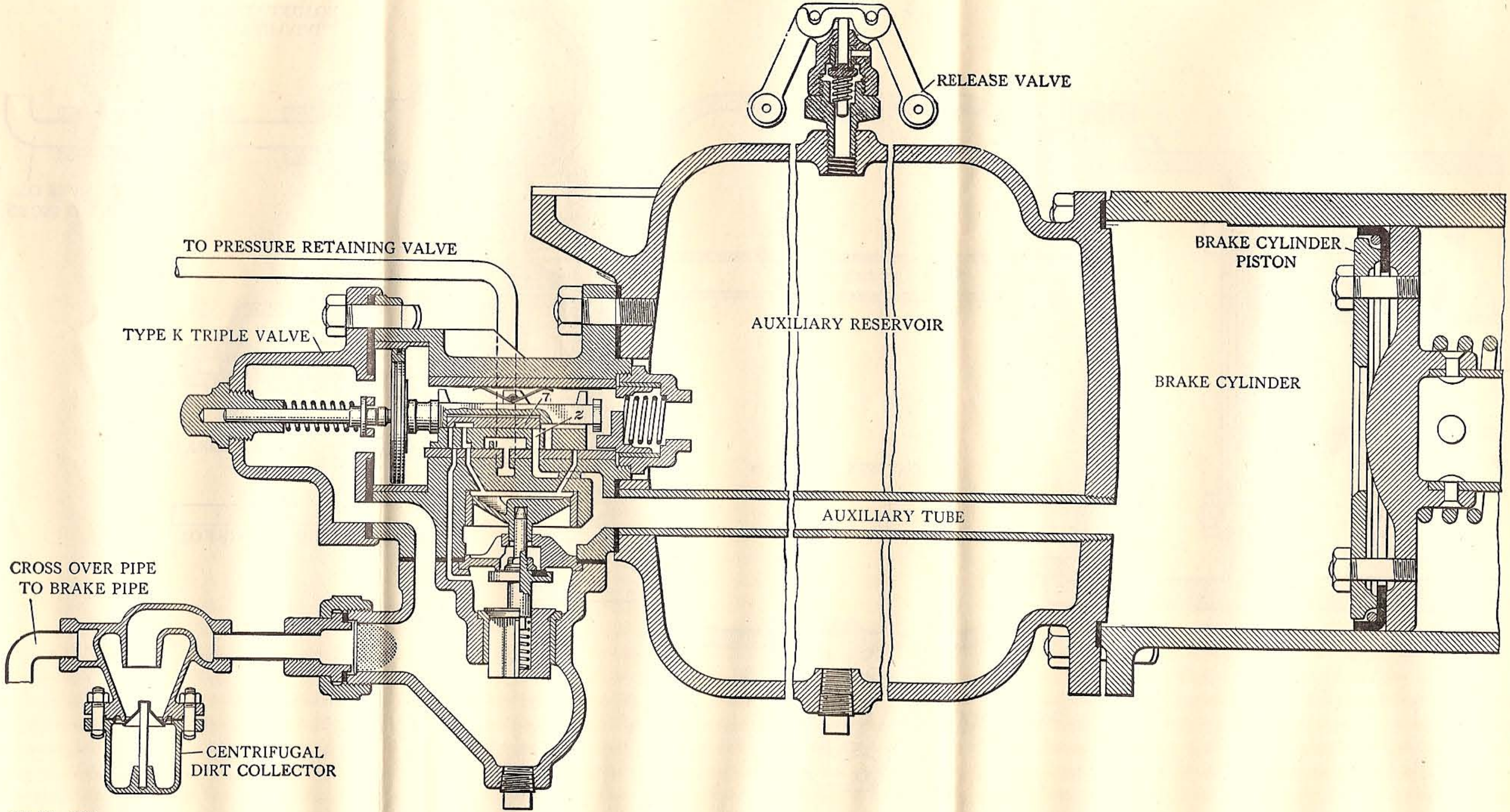


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Fig. 17

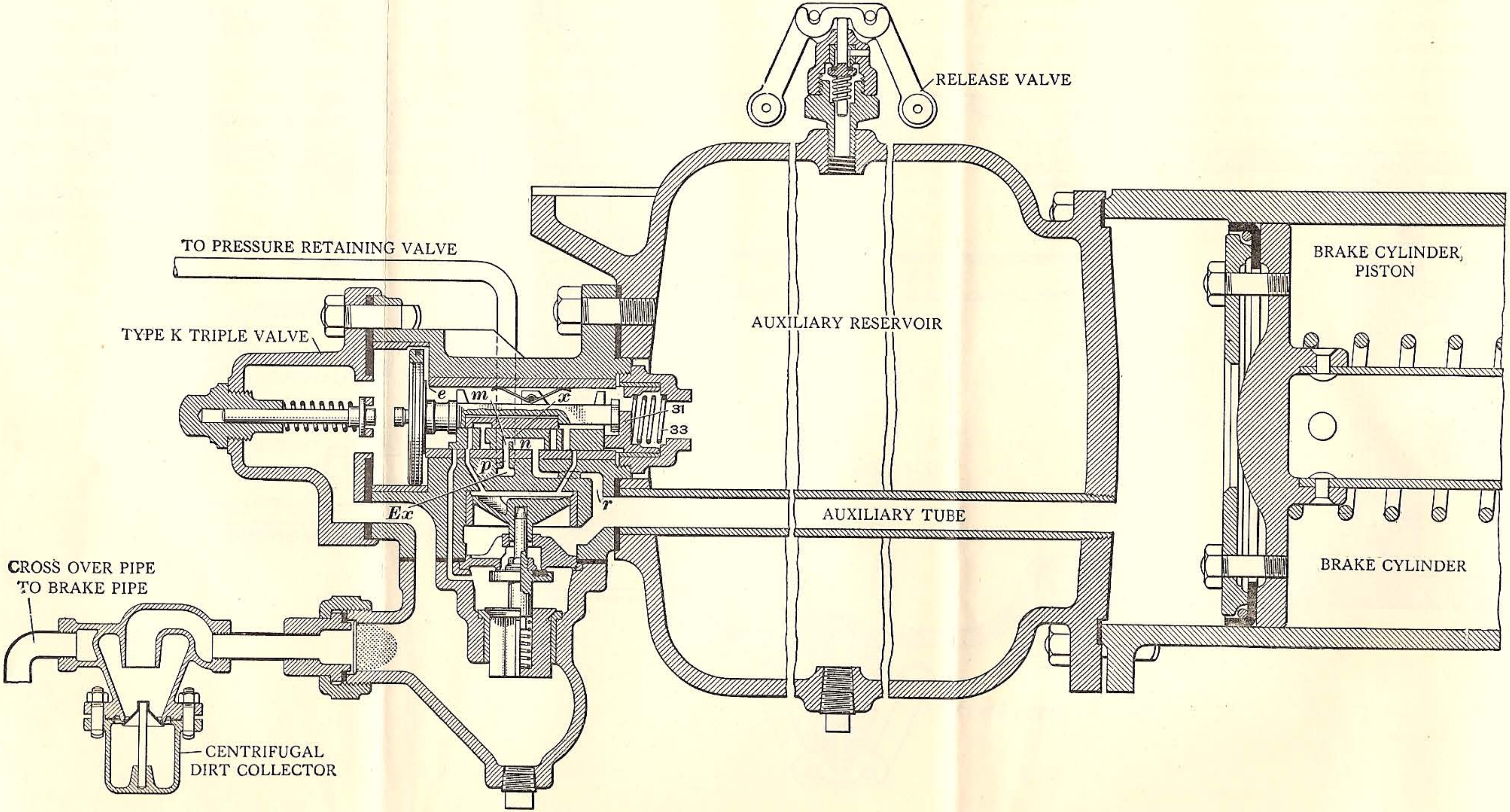

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Fig. 18

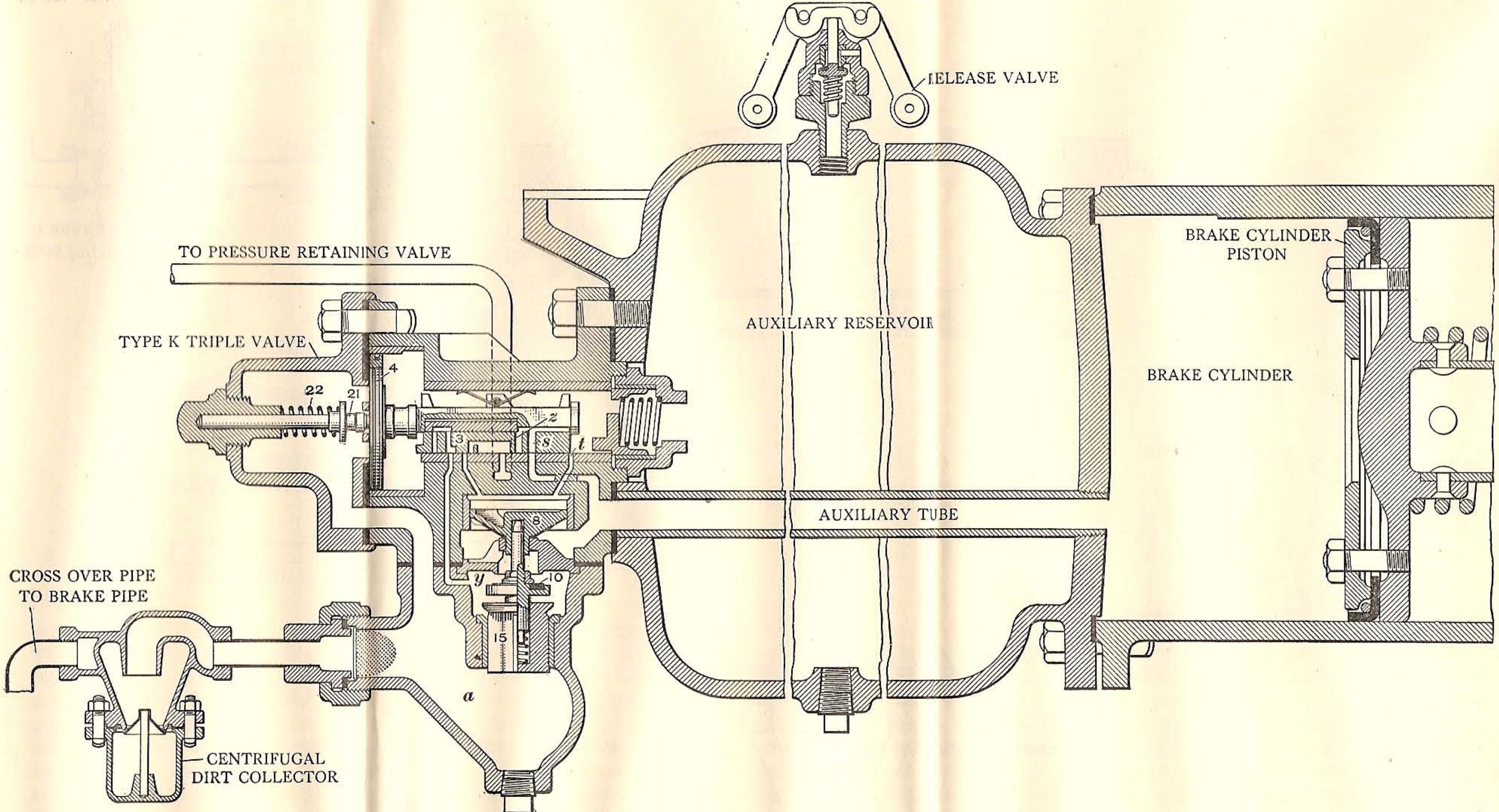

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Fig. 19

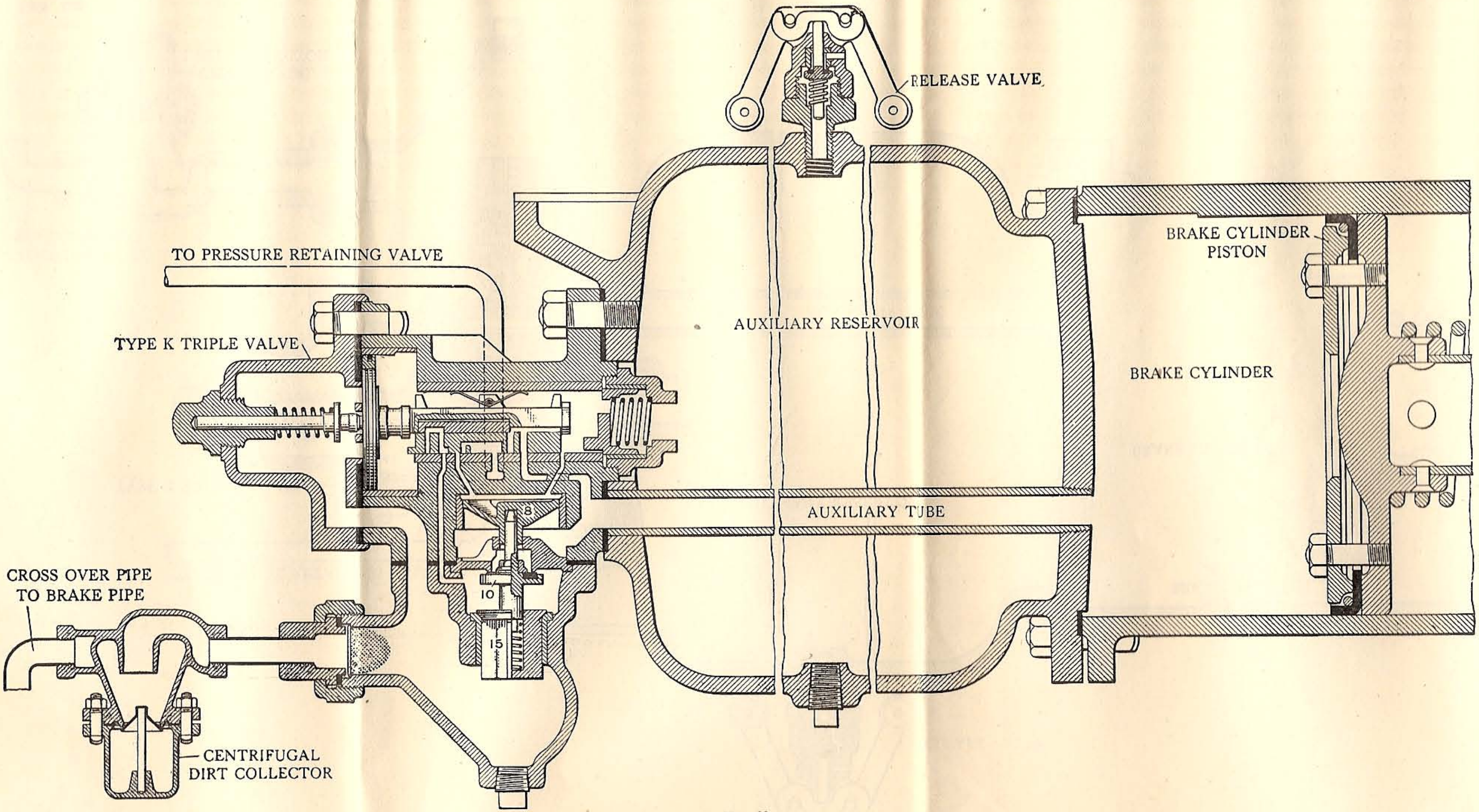

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Fig. 20